COMMISSION OF THE EUROPEAN COMMUNITIES

ESPRIT III

Basic Research Project 8579

MIAMI

Multimodal Integration for Advanced
Multimedia Interfaces

TECHNICAL ANNEX

12th October, 1993

Contents

I DESCRIPTION OF THE PROJECT

I.1 Project Overview

I.1.1 Abstract

This project aims at developing approaches for building integrated representations of multimedia data by modeling certain basic properties of the Human Information Processing system (HIP). In **MIAMI**, we want to study full multimodality aspects in accessing, representing and producing multimedia information by visual, acoustical and tactile/gestural systems. The main aspect studied is how to build integrated representations of different modalities as they occur at many levels of processing. This integration is useful, both in the disambiguation of the human input to the system and in the disambiguation of the system output.

In the case of human input to a system, the use of multimodality yields noise reduction through redundancy, and adds semantics, e.g. arguments, to a command. A simple example is the use of voice command input in teleoperation to specify movement parameters like "careful" or "forceful", or in the use of handwriting in case of speech misrecognition. Alternatively, in the case of system output, human mis-interpretation can be equally avoided through redundance, and by using multimodal modifiers of the output. An example is the use of prosody in voiced system error messages, or the coding of the speech source locations for different types of messages in 3-D space.

MIAMI follows the human information processing by providing and analyzing data on selected aspects of human multimodal data processing and devising an architecture for revealing and exploiting its integrative capabilities. To avoid complexity bottlenecks, a systematic, bottom-up approach combining accumulated knowledge, psychophysical experiments and deductive thinking is applied for developing new algorithms and their experimental verification in laboratory tests and practical applications. Application side is stressed by developing two typical scenarios for multimedia information acquisition, representation, and use. The first scenario is related to symbolic information retrieval and develops an "Information City" metaphore. The second scenario is related to the interaction and manipulation in information space as exemplified by teleoperation. The scenarios cover fundamental aspects of multimedia data handling and are close to real practical applications.

I.1.2 Role of the Partners

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Partners

DIST – Universita di Genova, Italy
ICP – Universite Stendhal, Grenoble, France
RIIT – Tampere University of Technology, Finland
UKA – Universität Karlsruhe (TH), Germany
RUB – Ruhr-Universität Bochum, Germany

I.1.3 Resource Breakdown

			Project No.		8579
III.1.1 Title					
MULTIMODAL INTEGRATION FOR ADVANCED MULTIMEDIA INTERFACES					
III.1.2 Acronym		MIAMI			
III.1.3 No.	III.1.4 Organisation Name	III.1.5 Country	III.1.6 Role	III.1.7 Assoc. to No.	III.1.8 Effort in Person Months
1	NICI NIJMEGEN	NL	C		36
2	DIST GENOA	I	P		36
3	ICP GRENOBLE	F	P		36
4	RIIT TAMPERE	SF	P		36
5	UKA KARLSRUHE	D	P		36
6	RUB BOCHUM	D	P		36
				TOTAL	216
III.1.9 Project duration in months					36

Figure 1: Breakdown of resources

I.2 Objectives, Expected Results and Exploitation Plans

I.2.1 Objectives

The major objective of this project is to find new ways of integrating multimedia data for use in advanced information processing systems. Present computers rely increasingly on multimedia data for input and output. Integration of these data is provided only on a very basic level of temporal synchronization. In fact, different media are handled separately in completely different ways as regards their content. On the other hand, it is evident that humans operate using much more sophisticated integration techniques. Visual, acoustical and tactile/gestural input and output systems operate in perfect coordination and interdependence. They form an integrated system which can receive and produce complex multimedia presentations.

Even if only some of the human multimedia capabilities are going to be reproduced in information processing devices, it is necessary to go far beyond the present state-of-the-art and consider multimedia integration in much deeper sense than only synchronization. The paradigm of **MIAMI** is that any approach towards such an integration should follow the capabilities already existing in the human information processing system which is highly optimized in this respect. The human system is capable of dealing with enormously complex tasks, many of which can not be tackled by today's information technology, such as providing textual descriptions of visual scenes, or producing theatrical improvisations.

However, the operation of the human information processing system can be studied, modeled, and algorithms can be devised for dealing with more simple tasks, in which media integration and representation play a significant role. Among such tasks will be, for example, coordinated acquisition and production of nonverbal sound, visual and tactile/gestural information. This can be considered as a first step in a systematic, bottom-up approach to study the multimedia data integration and representation problems. At the same time, complexity bottlenecks can be avoided and useful, practical results can be achieved.

In this project, the paradigm of following the human information processing capabilities is used in a multitude of ways to fulfill several aims which are necessary to achieve the main objective. These aims are:

1. Providing experimental data on selected aspects of human multimodal data processing relevant for use in the design of advanced multimedia systems. The focus will be on multimodal manipulation of data in an experimental setup.

2. Building an architecture for revealing and exploiting the integrative capabilities of the human information processing system for different modalities.

3. Specifying two typical scenarios for multimedia information acquisition, representation and use, which address the continuum of analog vs. symbolical representation and control future.

4. Demonstrating and evaluating the scenarios which are presented in a suggestive form for a potential application area.

I.2.2 Expected Results

The project is expected to provide:

1. New ideas and models for multimodal data acquisition, processing and representation. A workbench of tools will be developed for experimenting in multimodal research.

2. New algorithms and designs for advanced multimodal interfaces and multimedia presentations. Standardized architecture will be developed as a platform for the creation of applications.

3. Clarification of the fundamental difference between discrete, symbolic vs. analog representation and control of information. This will be done by choosing typical application scenarios which represent the extremes of this continuum.

I.2.3 Exploitation Plans

Multimedia is the technology of the future and this project is of primary importance for next generation information processing systems. These systems will be evolving from the present "computers" to integrated information assistants, managers and communicators. This project is focused on a central issue of integrated handling of information acquired by different modalities and presented in a multimedia context. The ideas, models, and algorithms produced in this project are most likely to exert a profound influence on a whole range of future information technology products. This is reflected in the enclosed letters of endorsement supplied by companies which were presented with the initial plan of this project. To facilitate the transfer of results into practice, the consortium plans to:

1. Use the results in other industrial projects in which partners of this consortium participate, especially in the area of advanced multimedia computer interfaces. One of them is the RACE project DIAMOND (Domestic IBC Applications of Multimedia on Demand) (RIIT Tampere). Another project is related to the application of results to theatrical performance which is of direct interest to the Consortium Centro dei Dogi in Genova (DIST Genova) responsible for international expositions and state of the art cultural initiatives. The IRAS project, where the IPR (Karlsruhe) participates, provides an ideal industrial background for the evaluation of **MIAMI**'s results in a challenging application area (teleoperation).

2. Create an "Industrial Liaison Board" (ILB) composed of major European companies and institutions, which will be supplied with progress reports and published results.

3. Members of the Industrial Liaison Board (ILB) will be invited to take part in two workshops organized in the middle and in the end of the project to demonstrate the newest developments within **MIAMI**.

II PROGRAMME OF WORK

II.1 Introduction to the Workplan

The **MIAMI** project deals with acquisition, representation and presentation of multimodal information in advanced multimedia systems. This topic can be easily visualized just by recalling the operation of the Human Information Processing system (HIP). In this system, three main subsystems: visual, acoustical and haptic (tactile+gestural), work in perfect harmony, receiving multimodal inputs and producing complex multimedia presentations. Although simple to visualize, the harmony covers complexities of high order which only now we are starting to realize. Even a single subsystem is very complex, like, for example, the acoustical one with its capability for continuous speech production and recognition. Cooperation of several subsystems in reception and production of information increases the complexity. Research in this area is continuously becoming more and more important, since modern computer systems can be equipped with all input and output devices corresponding to the three information subsystems of humans, and can process massive amounts of data. While the computational power available is increasing, the knowledge of how these devices should be used in order to achieve certain human-like capabilities is very limited. What we need are thus models and algorithms which simulate such capabilities.

Facing the challenges, but also complexity bottlenecks, **MIAMI** proposes to overcome them by a carefully selected strategy:

- The investigation will be bottom-up. The starting point will be a detailed characterization of basic problems and a taxonomy according to their complexity.
- The guiding example will be the Human Information Processing system. A selected set of experiments will be done to test the performance, and gain insight about multimodal aspects of operation.
- The application-oriented character of the research will be emphasized by investigating multimodal interactions in several scenarios close to real practical applications.
- Partners with expertise in single modalities will be working in teams studying interaction of different modalities. Integration phases will be organized to synthesize the results.
- For the overall presentation of the results at the end of the project two demonstrators that will complement each other, thus covering most part of application areas for multimedia technology, have been chosen. The first one is related to *Information Retrieval Systems*, representing the symbolical part of multimodal integration; whereas the second one which represents the analogical part is related to the area of *Telemanipulation and Teleoperation*.

Although the exact implementation of the final demonstrations will be dependent on the (basic) research results from this project, the two basic demonstration setups described in II.2.4 are envisaged.

II.1.1 Risk Assessment

The main sources of risk in this project stem from its advanced character. Each partner owns a different viewpoint, and considerable effort will be required to harmonize positions. The project builds on a body of accumulated knowledge about different information modalities. Integrating and extending this knowledge and building a model of multimodal processing is definitely not an easy task. In order to minimize the risk involved, a prudent strategy of bottom-up approach with experiments based on minimum transfer of information will be applied. This will guarantee that practical results will be obtained dealing with basic aspects of integration.

Another risk in general is the development of application demonstrators. This risk will be minimized due to the particular composition of the consortium. The demonstrators will be based on models and tools resulting from other projects and activities that the partners are able to bring into **MIAMI**. This refers for example to speech synthesis and recognition, "talking face", handwriting synthesis and recognition, pen gesture recognition, and hardware parts of application scenarios. Thus, it will not be necessary to develop basic modules for single modalities and equipment for tests.

The approach used in **MIAMI**, namely to follow a two-fold strategy, promises to cope efficiently with the risks mentioned above. The strategy in this project consists of

1. the bottom-up approach, leading to a solid basis of multimodal integration through numerous exchange of sophisticated knowledge between partners, and

2. the clear definition of the goals to reach, i. e. the implementation of the two demonstrators described in WP 4.

Thus, the starting points and the goals are well-defined in the beginning, but the question how to reach them has to be answered during the project itself.

II.1.2 Options Available to Meet the Objectives

A central issue within the **MIAMI** project is the development of multimedia data representations and processing models which are based on results from experiments with human subjects. We concentrate on lower levels of integration which seem to be amenable to the proposed experimental-theoretical methodology of investigation. The alternative would be a more theoretical, but also more speculative approach of building a full theory of the acquisition and representation of multimodal data by the Human Information Processing system. Although a long history of research exists within experimental psychology, biophysics and neurophysiology, the questions asked are often very remote from the actual problems currently encountered in multimedia technology.

The approach which is proposed in **MIAMI** seems to be more suitable since it guarantees quantitative and verifiable results, which are relevant for practical multimedia applications. Therefore, the two demonstrators which will be shown at the end of the project have been chosen carefully as complementing each other to cover the most part of application areas where multimedia technology will have great influences in the next years.

II.2 The Workplan

The research in **MIAMI** is organized in four Workparts which can be broadly characterized as Preparation (WP1), Experimentation (WP2), Consolidation (WP3), and Demonstration (WP4). The *First Workpart* concerns a preparation on the experiments, by defining concepts, marking the exact boundaries of the research, and providing a common experimentation platform for the bimodal experiments in WP 2. In the *Second Workpart*, partners are cooperating in bimodal experiments on human output/system input, and on system output/human input, for the different modalities. The results of the experimentation will lead to a definition of a system architecture (the *Third Workpart*, containing the basic functionality which is needed for a demonstration of the basic findings. Finally, in the *Fourth Workpart*, two demonstrations are prepared, elucidating basic properties of Symbolic (demonstration I) and Analog (demonstration II) Information Processing.

II.2.1 WP 1 – Taxonomy of multimodal interactions in the Human Information Processing system (HIP)

This Workpart is an initial stage of the project, aiming at developing a common platform for partners' cooperation. In the initial phase, the known body of results about visual, acoustical, and haptic systems will be collected by partners, distributed and assessed. Next, the taxonomy of multimodal interactions with respect to information flow will be developed. This will be done by considering different levels of processing and integration.

It is well known that each of the subsystems of HIP can operate separately and built representations which are much related. For example, a representation of spatial relations can be built by inputs from visual, acoustical, and tactile systems. The visual input is clearly the richest, but the most important aspect here is that all the representations are overlapping. In fact, there might be only a single common representation of basic spatial properties, relying on inputs from all the subsystems. When two or more systems cooperate, the representation is enhanced. Highly specialized systems operate to built such a representation (e. g. stereoscopy in vision and sound), which can also be memorized, recalled, and easily manipulated. One special aspect is conversion: a representation built by one system can be used by another one. For example, if a visual representation of a room is built, a person can move even in darkness using memory and a tactile system.

On a different level of processing there are representations which serve in human communication and are thus "symbolic". They cover an enormous range, e. g. from simple sounds to complex language expressions. These representations are learned, and the represented concepts can be associated with any type of inputs and outputs from the different HIP subsystems. This again suggests that there is one common representation that is built incrementally and relies on continuous enhancement by using different modalities.

The taxonomy built in this Workpart will be used for developing a general cybernetic model concentrated on multimodal interaction, a common representation, and memory. The model will serve as a basis for the development of experimental procedures with human subjects. From a technical point of view, the taxonomy and the model will be used to assess problems arising in practical realizations of multimodal data acquisition and representation in computer systems.

II.2.2 WP 2 – Integrating Modalities: Experiments testing human multi-modal processing

In this Workpart, a set of experiments will be carried out on human subjects. The aims of the experiments are:

(a) checking and obtaining insight about the multimodal performance;

(b) development of detailed models of processing.

While in the fields of perception research and experimental psychology, many similar experiments are studied, our approach is oriented towards practical technical solutions and is integral with application scenarios described later. To deal with the complexity bottlenecks, minimized information transfer will be used. The experiments will be realized for several different aspects of processing:

a) Spatiotemporal representation and integration in HIP input subsystems

An important topic is how presentations of different modalities are combined with regard to spatiotemporal representation and integration. This can for example give information on how to attract and manipulate attention in multimedia representation. The starting point of our investigations will be the combination of visual and acoustic modalities. A lot of psychophysical experiments on this topic have been performed yet and are available from the literature. However, those investigations generally did not aim at finding a model for the common representation which is the ultimate goal of our experiments. Thus we have to start with quite simple experiments, approaching towards more and more complex and realistic scenarios. Topics that will be addressed within the experiments are:

1. how visual and acoustical information is combined to form unique objects;
2. how acoustic and visual presentations have to be designed and combined to attract and control attention (acoustic and visual icons).

To deal with the first task, visual and acoustic representations will be presented that may show congruent or divergent temporal or spatial characteristics. The characteristics that will be assessed are spatial positions and overlap, synchronous or non-synchronous motion, etc. We will start with a quite simple test condition in which a moving light dot will be displayed, either in two or three dimensions on a screen or using stereoscopic goggles. An acoustical point source will be presented to the subjects via headphones. The performance of the HIP to form single objects will be tested if the locations are overlapping or disparate and movements are synchronous or asynchronous. The aim is to derive a numerical description about to what extend the spatial and temporal attributes of visual and acoustic representations may deviate in order to form single objects.

The second task is based on the general need of multimedia representations to deal with the attention aspect. Concrete questions that will be investigated on are:

- how to achieve improvement in reaction times: using visual icons or acoustical icons separately or using combined icons. The reaction can be measured by means of tracking the head movement of a subject in front of the screen when specific icons are presented;

- how to achieve improvement of the perception of the meaning of icons: which icon can more easily be translated into a corresponding action that has to be performed.

As an advanced example that will form one of the addressed scenarios, we can regard an application where a multimodal representation is used to monitor and control a complex technical process on a big screen. If any of the parameters changes in such a manner that the controlling person has to be informed in order to react to that change, the first task is to focus his attention on the parameter. If the parameter is presented only by a visual icon, problems to attract attention arise if the icon is outside of the visual field or even at the periphery of the visual field. An additional acoustical icon that is assigned with a spatial position pointing to the visual icon is supposed to focus attention should yield a better performance. The second task is to inform the controlling person which action he should perform due to the change of the parameter. This can be achieved if the icons carry obvious meanings.

b) Visual and acoustical integration in HIP input at a symbolic level

Symbolic integration is much more complex since it depends on complexity of symbols, highly sophisticated processing, and memory. Nevertheless, experiments can be designed to reveal information about integrative processing. In these experiments, visual and acoustical inputs will be given in the form of simple sounds, corresponding to letters and words. ICP (Grenoble) has gained a lot of experience in similar experiments in the past. The experiments to be conducted in **MIAMI** will be based on those results using extended test scenarios. A testbed will be arranged by combining controlled screen displays with loudspeakers/headphones. Visual inputs will be given in the form of face/lip movement or/and written text. Corresponding acoustical input will be supplied. The human recognition rate will be tested and compared with both systems in operation as opposed to the single system. The tests will concentrate on operation in noisy and disturbing environments. Noise of various types and fading will be used to establish perceptual thresholds and the enhancement of recognition due to multimodal stimulation. Different input conditions will be used (speed, size of visual input, reduced sound quality, spatial distribution of sound sources, etc.) to check the cooperation and integration of results. Basically brief stimulations, both synchronized and desynchronized, will be investigated.

c) Visual and haptic integration

In this set of experiments, haptic and visual integration will be tested for two practically important cases of manipulation and handwriting. A manipulator with tactile feedback will be used to perform remotely simple manipulations with controlled visual participation via camera and monitor. The images will be varied in detail, quality and amount of noise. Impact of temporal and spatial synchronization will be tested for a manipulator with typically nonideal operation. Enhancement due to visual input will be assessed and fusion data from both systems will be evaluated. In a second set of experiments, the very important case of handwriting integration will be studied. Human subjects will be drawing and writing on a covered tablet, without visual input. Visual input will be activated in a controlled way by displaying the material to be written and the results of writing on a monitor. Performance will be tested for the role of visual input in speed and precision under varying amounts of features presented on the screen, under disturbances, noise, and temporal and spatial desynchronization. With respect to the models we are going to develop in WP 3, two different aspects are covered by this integration task. First, integration of gestural output with visual input from the operator's point of view. Second, the use of gestural output for control purposes, and the visual perception of the gestures by the controlled system.

II.2.3 WP 3 – Development of System Architecture for the Acquisition, Integration, and Representation of Multimodal Information

This Workpart follows the experiments on humans in Workparts 1 and 2 and aims at defining a generalized architecture for multimodal data acquisition and representation. This will lead to a software library which will be applied in the two scenarios in WP 4. In a first step software models for the processing of multimodal input, the representation of multimodal objects, and the production of multimedia output will be developed. This will be done by adapting well-kwown unimodal structures and integrating them in a multimodal representation which will take the experimental results of WP 2 into consideration.

Founded upon this basic architecture, in the following steps various ways of operating in a multimedia environment will be realized. This includes the generation of virtual objects, the navigation in virtual and real environments, and the interaction with real and virtual objects. With respect to the demonstrators for each application a set of suggestive operations is composed. In order to improve the efficiency of the interaction between a human user and a multimedia system, a mechanism for detecting typical user actions will be provided.

II.2.4 WP 4 – Development of Application Scenarios for Technology Demonstrators

In the last phase of the project, the system architecture developed in Workpart 3 has to be modified according to the needs of the two demonstrators that will be shown at the end of the project. The first one is related to *Information Retrieval Systems*, representing the symbolical part of multimodal integration. The second demonstrator which represents the analogical part is related to *Telemanipulation and Teleoperation*. These two scenarios have been chosen as complementing each other to cover most part of multimedia technology with multimodal input and output, from the user and the system side.

I. The Symbolic Scenario: Efficient Interaction and Manipulation Through Information Space Using Multimodality and Topological Modeling

In this demonstration, use is made of the knowledge on navigation and on object control which was collected during the experiments. The goal is to facilitate the access to symbolical information, such as is currently stored on multimedia products, but which still is characterized by strong limitations and access thresholds. Based on the current success of work environment metaphors, such as the desktop metaphor and the graphical office metaphor, we propose in this demonstration an "Information City" metaphor, where the user can navigate, mainly but not exclusively using symbolical/discrete control. Also, in this demonstration, use is made of the knowledge gained in multimodal system output rendering, especially with respect to the "talking face" and the acoustical "ear-cons". By presenting a closed conceptual model of the Information City which maps onto the actual information which is accessed, the user will have a rich context from which to derive a consistent internalized mental model of the system and the information presented.

Problems of local/global and absolute/relative coding of movement and the information environment will be elucidated, and solutions will be proposed.

II. The Analog Scenario: Efficient Interaction and Manipulation Through Information Space Using Multimodality, Geometry and Time

As of today, teleoperation is done by an operator who physically controls a remote manipulator. Despite all efforts to build autonomously acting robots which could perform the desired tasks on their own, the human operator is part of the teleoperation systems used nowadays. One of the most used control strategies is to supervise the robot during its performance and to enter the control loop if an exception or an error occurs which causes a problem that can not be solved by the robot autonomously.

Both tasks performed by the operator, the supervision of the system and the interaction in case of exceptions and unforeseen events, can be simplified by the use of a combination of visual, acoustical, and gestural input and output. Such a multimodal teleoperation system which will be presented at a workshop at the end of the project will present a man-machine-interface that results in a safer, faster, and more comfortable operation.

To give an example, the head of the operator can be monitored by a camera in order to stop the operation if he is not watching the scene. Thus, a complete supervision without any breaks can be guaranteed. Moreover, recording and modeling the operators behaviour while he is performing a predefined task will result in the acquisition of control strategies and the detection of action patterns. The number and type of input channels plays a significant role in such Programming-by-Demonstration systems and can therefore be enhanced by a multimodal interface.

On the other hand, multimedia presentation can be used to attract and manipulate attention of the operator and improve the feedback. One example is the use of a force-reflecting joystick for the interactive manipulation of an object, another one the acoustical presentation of a sound to support the operator in situations where pictures or graphs on a screen are not sufficient. Such "ear-cons" could e. g. reflect the data which is measured by tactile or force-torque sensors during manipulation tasks in a way that is easy to understand and that allows efficient and safe reactions with respect to the task performed.

II.2.5 Breakdown of Resources and Project Time Schedule

The four workparts (WP) have been split up into worktasks, which will be presented in more detail in section II.2.6. The PERT on the next page shows the interdependencies between these single worktasks, the overall project structure, and the dates of milestones.

Figure 2: PERT of MIAMI - Project Years 1 – 3

The following table (Table 1) shows the breakdown of resources in manmonths per partner and workpart, whereas Figure 3 shows the rough time schedule of the project, i. e. the duration of each workpart.

	WP 1	WP 2	WP 3	WP 4	Total
NICI	5	7	9	15	36
DIST	4	9	8	15	36
ICP	5	12	8	11	36
RIIT	5	10	9	12	36
UKA	6	6	9	15	36
RUB	5	11	8	12	36
Total	30	55	51	80	216

Table 1: Manmonths per Partner and Workpart

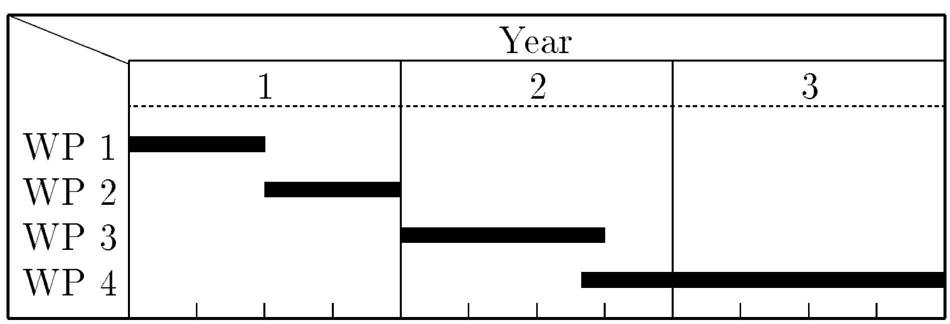

Figure 3: Duration of Workparts

II.2.6 The Work Description Sheets

This section consists of a detailed description of the single worktasks (WT). Each WT is presented on its own Work Description Sheet (WDS), which indicates e. g. the task manager, start and end date, participating partners, objectives, and the approach which has been chosen to reach these objectives.

WORK DESCRIPTION SHEET

ESPRIT BASIC RESEARCH Project 8579 MIAMI	WP No. 1	WT No. **1.1**
Task title: **Taxonomy** Partner responsible: NICI Start date: 01/01/94 End date: 31/03/94 Task manager: L. Schomaker Planned resources: NICI: 2 - DIST: 2 - ICP: 2 (in man-months) RIIT: 2 - UKA: 2 - RUB: 2		Sheet 1 of 1 Issue date: 08/10/93

Objective:

This work task concerns the definition of multimodal channels and their suitability for use in multimedia interfaces. State of the art literature of research in the different modalities is identified. The taxonomy is a concise hierarchical description of modalities in human-computer interaction.

Input:

State of the Art, Experiences and Taxonomy from other projects

Output:

Common Glossary & Taxonomy

Approach:

- Define the structure of the taxonomy
- Define the glossary of terms
- Identify state of the art research for each of the components in the taxonomy
- Clarify the subset of modalities covered by **MIAMI**

Contributions:

ALL state of the art expertise

WORK DESCRIPTION SHEET

ESPRIT BASIC RESEARCH Project 8579 MIAMI	WP No. 1	WT No. **1.2**
Task title: **Experimental design** Partner responsible: NICI Start date: 01/03/94 End date: 30/06/94 Task manager: L. Schomaker Planned resources: NICI: 3 - DIST: 2 - ICP: 3 (in man-months) RIIT: 3 - UKA: 4 - RUB: 3		Sheet 1 of 1 Issue date: 08/10/93

Objective:

Definition of a common, and basic experimental platform which enables the study of bimodal *control* and *perception*. In case of bimodal *control*, the paradigm consists of a virtual world of polyhedrons. Both analog and symbolic control modes are addressed. Characteristics of the polyhedrons (shape, kinematics, sound) are controlled through two modalities. In case of bimodal *perception*, the same paradigm is used to test psychophysical aspects of spatial source localization.

Input:

WT 1.1

Output:

Experimental software for bi-modal experiments

Approach:

- Develop a basic Xwindows graphics program for rendering moving 3-D polyhedrons
- Define object characteristics (shape, kinematics, and sound)
- Define control modes and perceptual variables
- Basic documentation

Contributions:

ALL software; ALL documentation

WORK DESCRIPTION SHEET

ESPRIT BASIC RESEARCH Project 8579 MIAMI	WP No. 2	WT No. **2.1**

Task title: **Experiments: Visual-acoustical perception** Partner responsible: RUB Start date: 01/07/94 End date: 30/11/94 Task manager: K. Hartung Planned resources: RUB: 6 - RIIT: 6 (in man-months)	Sheet 1 of 1 Issue date: 08/10/93

Objective:

Evaluation of intermodal effects in the perception of visual/acoustical objects: Localization of objects (separation of objects, fusion of objects); Movement of objects; Directing attention to objects; Divided attention to objects; Intermodal enhancement in task performance.

Input:

WT 1.1, WT 1.2

Output:

Report with results

Approach:

- Definition of test parameters
- Development of test procedures
- Psychophysical tests with human subjects
- Evaluation of results

Contributions:

RUB experiments, additional software; RIIT experiments

WORK DESCRIPTION SHEET

ESPRIT BASIC RESEARCH Project 8579 MIAMI	WP No. 2	WT No. **2.2**

Task title: **Experiments: Visual-speech perception** Partner responsible: ICP Start date: 01/07/94 End date: 30/11/94 Task manager: C. Benoit Planned resources: ICP: 6 - RUB: 1 (in man-months) RIIT: 3 - DIST: 2.5	Sheet 1 of 1 Issue date: 08/10/93

Objective:

To evaluate and understand how auditory and visible speech are integrated by humans: Evaluation of the natural anticipation of vision on audition in speech perception; Influence of vision on auditory speech intelligibility in adverse conditions; Visual disambiguation in the cocktail party effect; Effect of channel desynchronization on audio-visual speech perception; Effect of a spatial delocalization of the sources on speech intelligibility; Evaluation of the McGurk effect (contradictory stimuli); Intelligibility of distorted videophone face images.

Input:

WT 1.1, WT 1.2, WT 2.1

Output:

WT 2.8, WT 3.2, WT 3.4, WT 3.6

Approach:

- Definition of test conditions
- Development of test procedures for natural and synthetic stimuli
- Psychophysical tests with human subjects
- Analysis and interpretation of results

Contributions:

ICP experiments; RUB spatialization of speech recordings; RIIT videophone experiments; DIST experiments

WORK DESCRIPTION SHEET

ESPRIT BASIC RESEARCH Project 8579 MIAMI	WP No. 2	WT No. **2.3**

Task title: **Experiments:** **Visual-gestural control** Partner responsible: DIST Start date: 01/07/94 End date: 30/11/94 Task manager: A. Camurri Planned resources: DIST: 3 - NICI: 1 - UKA: 2 (in man-months)	Sheet 1 of 1 Issue date: 08/10/93

Objective:

To study the analog control of virtual objects on the experimental platform with a pen interface: manipulation (dragging, moving, deforming); Targeting; Exploring the number of controlling degrees of freedom (pen-tip position, axial force, pen orientation). To evaluate and understand how music and human movements are integrated, by means of common metaphorical approaches.

Input:

WT 1.1, WT 1.2

Output:

Software to be used in WP 3 and WP 4, Results to be reported in WT 2.8

Approach:

- Definition of test parameters and evaluation criteria
- Development of test procedures
- Experiments with human subjects
- Evaluation of results

Contributions:

DIST experiments; NICI experiments; UKA experiments

WORK DESCRIPTION SHEET

ESPRIT BASIC RESEARCH Project 8579 MIAMI	WP No. 2	WT No. **2.4**
Task title: **Experiments: Handwriting-visual control** Partner responsible: NICI Start date: 01/07/94 End date: 30/11/94 Task manager: L. Schomaker Planned resources: NICI: 2 - ICP: 2 - DIST: 2.5 (in man-months)		Sheet 1 of 1 Issue date: 08/10/93

Objective:

To study the pen-driven, symbolical control of virtual object parameters on the experimental platform using Pen Gestures and Handwriting. This concerns experiments addressing timing aspects, as well as representational aspects on the input side (commands, gestures) and the output side (graphical rendering of virtual polyhedrons and the virtual face). Experiments on: Handwriting control of motion and shape; Gestural control of motion and shape; Facial feedback on recognizer status.

Input:

WT 1.1, WT 1.2

Output:

WT 2.8, WT 3.1, WT3.4 – 3.6

Approach:

- Software integration of pen library with experimental platform
- Experiments in handwriting/gestural control of motion and shape
- Experiments in facial expression feedback
- Evaluation of results

Contributions:

NICI software, experiments; ICP virtual face rendering software; DIST human movement expertise

WORK DESCRIPTION SHEET

ESPRIT BASIC RESEARCH Project 8579 MIAMI	WP No. 2	WT No. **2.5**

Task title: **Experiments: Handwriting-speech control** Partner responsible: NICI Start date: 01/07/94 End date: 30/11/94 Task manager: L. Schomaker Planned resources: NICI: 2 - ICP: 2 (in man-months)	Sheet 1 of 1 Issue date: 08/10/93

Objective:

Current recognizer performance is still not optimal, both in the case of speech and in handwriting recognition. However, providing for multimodal user interfacing and easy correction protocols to the user will potentially solve this problem to a large extent. In this work task the new area of combined handwriting and speech recognition is addressed.

Input:

WT 1.1, WT 1.2

Output:

Software for bimodal interaction and for combining recognizer output, experimental results.

Approach:

- Developing a combined speech recognizer and handwriting recognizer setup on the basis of existing technology
- Experiments in Handwriting (cursive script) and Speech recognition
- Experiments in Pen Gestures and Speech recognition
- Evaluation of results

Contributions:

NICI software, experiments; ICP software

WORK DESCRIPTION SHEET

ESPRIT BASIC RESEARCH Project 8579 MIAMI	WP No. 2	WT No. **2.6**

Task title: **Experiments: Visual-motorial control** Partner responsible: UKA Start date: 01/07/94 End date: 30/11/94 Task manager: S. Münch Planned resources: UKA: 3 (in man-months)	Sheet 1 of 1 Issue date: 08/10/93

Objective:

Evaluation of performance in object manipulation with direct object manipulation or manipulation through a supervised robot; real and virtual object manipulation; expert vs. laymen as system operator

Input:

WT 1.1, WT 1.2, Experiences from the ESA project IRAS

Output:

Software to be used in WP 3 and WP 4, Results to be reported in WT 2.8

Approach:

- Definition of test parameters and evaluation criteria
- Development of test procedures
- Psychophysical experiments with human subjects (expert vs. laymen)
- Evaluation of results

Contributions:

UKA experiments

WORK DESCRIPTION SHEET

ESPRIT BASIC RESEARCH Project 8579 MIAMI	WP No. 2	WT No. **2.7**
Task title: **Experiments: Cognitive-acoustical aspects** Partner responsible: RUB Start date: 01/07/94 End date: 30/11/94 Task manager: K. Hartung Planned resources: RUB: 3 - NICI: 1 (in man-months)		Sheet 1 of 1 Issue date: 08/10/93

Objective:

Evaluation of the influence of auditory stimulus parameters on recognition, recall, discrimination and decoding of information (number of features to be decoded simultaneously, use of "real life" stimuli vs. designed stimuli ("ear"-cons))

Input:

WT 1.1, WT 1.2

Output:

Report with results

Approach:

- Definition of test parameters
- Development of test procedures
- Psychophysical tests with human subjects
- Evaluation of results

Contributions:

RUB experiment, software; NICI experiment

WORK DESCRIPTION SHEET

ESPRIT BASIC RESEARCH Project 8579 MIAMI	WP No. 2	WT No. **2.8**
Task title: **Dissemination of results** Partner responsible: NICI Start date: 01/12/94 End date: 31/12/94 Task manager: L. Schomaker Planned resources: NICI: 1 - DIST: 1 - ICP: 2 (in man-months) RIIT: 1 - UKA: 1 - RUB: 1		Sheet 1 of 1 Issue date: 08/10/93

Objective:

Results from the experiments on bimodal interaction must be collected and distributed among all partners. The results are evaluated in order to be able to define the system architecture in WP3.

Input:

WT 2.1 – WT 2.7

Output:

Interim Report 1

Approach:

- Collection of reports from WT 2.1 – WT 2.7.
- Distribution among partners
- Evaluation of results pertaining to WP3.

Contributions:

NICI coordination; ALL reports

WORK DESCRIPTION SHEET

ESPRIT BASIC RESEARCH Project 8579 MIAMI	WP No. 3	WT No. **3.1**

Task title: **Representation of input channels** Partner responsible: NICI Start date: 01/01/95 End date: 31/03/95 Task manager: L. Schomaker Planned resources: NICI: 3 - RUB: 1 (in man-months) RIIT: 1 - UKA: 1 - DIST: 1	Sheet 1 of 1 Issue date: 08/10/93

Objective:

Definition of the functional architecture and data structures concerning the handling of the multimodal input. Resolution, sampling and synchronisation will be addressed. With respect to the functional architecture, the handling of the asynchronous external events must be defined.

Input:

WT 2.1 – WT 2.8

Output:

WT 3.4

Approach:

- Definition of sampling parameters for the modalities
- Definition of resolution parameters for the modalities
- Definition of data structures
- Synchronisation of input streams
- Definition of event handling architecture

Contributions:

NICI software, documentation; RUB sound channels input/output parameters; RIIT hardware parameters; UKA teleoperator input parameters; DIST software, documentation

WORK DESCRIPTION SHEET

ESPRIT BASIC RESEARCH Project 8579 MIAMI	WP No. 3	WT No. **3.2**
Task title: **Representation of output channels** Partner responsible: RUB Start date: 01/01/95 End date: 31/05/95 Task manager: K. Hartung Planned resources: RUB: 5 - UKA: 1 - RIIT: 2 (in man-months) DIST: 2 -ICP: 2		Sheet 1 of 2 Issue date: 08/10/93

Objective:

Development of a software model for multimedia output with respect to interdependencies between modalities

Input:

WT 2.1 – WT 2.8

Output:

Software library for multimedia output to be used in WP 4.1 and WP 4.2

Approach:

- Definition of data formats for communication
- Definition of priorities according to the results of WT 2.1 – WT 2.7
- Development of output controller(s) for synchronization of modalities
- Integration and adaptation of software for auditory events (RUB)
- Integration and adaptation of software for (tele-)manipulation (UKA)
- Integration and adaptation of software for visual input/output and feedback (RIIT)
- (to be continued on next sheet)

WORK DESCRIPTION SHEET

ESPRIT BASIC RESEARCH Project 8579 MIAMI	WP No. 3	WT No. **3.2**

Task title: **Representation of output channels**

Partner responsible: RUB

Start date: 01/01/95

End date: 31/05/95

Task manager: K. Hartung

Planned resources: RUB: 5 - UKA: 1 - RIIT: 2
(in man-months) DIST: 2 -ICP: 2

Sheet 2 of 2

Issue date: 08/10/93

Approach: (Continuing from previous sheet)

- Development and integration of software for the management, at the same level, of music/sound structures and movement patterns of real or virtual robots (DIST)
- Integration and adaptation of software for speech output and artificial face (ICP, DIST)

Contributions:

RUB audio software; UKA (tele-)manipulation software; RIIT software; DIST music/sound and movement software; ICP speech and artifical face software

WORK DESCRIPTION SHEET

ESPRIT BASIC RESEARCH Project 8579 MIAMI	WP No. 3	WT No. **3.3**

Task title: **Representation of object space** Partner responsible: UKA Start date: 01/01/95 End date: 28/02/95 Task manager: S. Münch Planned resources: UKA: 1.5 - DIST: 2 - RIIT: 1 (in man-months)	Sheet 1 of 1 Issue date: 08/10/93

Objective:

To find a common representation of object space which will be used in the following worktasks by all partners and for all modalities. Thus, together with WT 3.1 and WT 3.2, a framework will be established in which the demonstrators can be developed and implemented.

Input:

WT 2.1 – WT 2.8

Output:

Software library for multimedia representation to be used by all partners in WT 3.4 – WT 3.8 and in WP 4

Approach:

- Definition of data formats for representation
- Integration and adaptation of well-known unimodal representations into one multimodal representation

Contributions:

UKA software; DIST software libraries; RIIT parameters and software

WORK DESCRIPTION SHEET

ESPRIT BASIC RESEARCH Project 8579 MIAMI	WP No. 3	WT No. **3.4**

Task title: **Generation of virtual objects** Partner responsible: NICI Start date: 01/06/95 End date: 31/07/95 Task manager: L. Schomaker Planned resources: NICI: 2 - UKA: 1 (in man-months) DIST: 1 - ICP: 2	Sheet 1 of 1 Issue date: 08/10/93

Objective:

To describe the ways in which the user can create new virtual objects on the basis of the proposed modalities. Objects are characterized by shape and other visual characteristics, as well as by acoustical properties and virtual physical (simulated-mechanical) properties.

Input:

WT 2.1 – WT 2.8, WT 3.1 – WT 3.3

Output:

WT 4.1, WT 4.2

Approach:

- Pen-driven object generation
- Image-processing driven visual object generation
- Robot in telemanipulation mode
- Briefly exploring possibilities of Optotrak-, Dataglove- and sound (e.g. phoneme)-driven object generation

Contributions:

NICI, report, software; UKA report, software; DIST report, software; ICP report, software

WORK DESCRIPTION SHEET

ESPRIT BASIC RESEARCH Project 8579 MIAMI	WP No. 3	WT No. **3.5**
Task title: **Navigation in virtual & real environments** Partner responsible: RIIT Start date: 01/06/95 End date: 30/09/95 Task manager: I. Defée Planned resources: RIIT: 3 - NICI: 1 - DIST: 1 (in man-months)		Sheet 1 of 1 Issue date: 08/10/93

Objective:

To develop an "Information City" metaphore as a virtual environment for topological modelling and navigation in multimedia data. To develop multimodal input and output navigation tools. To confront navigation problems in virtual and real environments on an example of museum application.

Input:
WT 2.1 – WT 2.8, WT 3.1 – WT 3.3

Output:
Model and software support for WT 4.1 and WT 4.2

Approach:

- Mapping of information space to city metaphore
- Conceptualization of integrated multimodal navigation
- Selection of input and output navigation modalities

Contributions:
RIIT model and visual modality software ; NICI experiment on navigation and position recall; DIST report, software

WORK DESCRIPTION SHEET

ESPRIT BASIC RESEARCH Project 8579 MIAMI	WP No. 3	WT No. **3.6**

Task title: **Interaction with virtual and real objects** Partner responsible: UKA Start date: 01/06/95 End date: 31/07/95 Task manager: S. Münch Planned resources: UKA: 2 - DIST: 1 - ICP: 2 (in man-months)	Sheet 1 of 1 Issue date: 08/10/93

Objective:

The development of sophisticated interaction methods – either for the interaction with real or virtual objects – which will be simplified by the use of multimodal manipulation methods.

Input:

WT 2.1 – WT 2.8, WT 3.1 – WT 3.3

Output:

A conceptual model for the architecture of an integrated multimodal interaction system.

Approach:

- Investigation of results from WT 2.1 – WT 2.7 with regards to the aspect of multimodality
- Integration and adaptation of uni- and bimodal software for object interaction and manipulation into a multimodal concept

Contributions:

UKA soft- and hardware; DIST report, software; ICP report real vs virtual faces

WORK DESCRIPTION SHEET

ESPRIT BASIC RESEARCH Project 8579 MIAMI	WP No. 3	WT No. **3.7**

Task title: **Allowable operations** Partner responsible: NICI Start date: 01/08/95 End date: 30/09/95 Task manager: L. Schomaker Planned resources: NICI: 2 - UKA: 1 - RUB: 1 (in man-months)	Sheet 1 of 1 Issue date: 08/10/93

Objective:

To define the set of operations the user can perform on virtual or remote objects in the demonstrations 4.1 and 4.2. The user operations concern the characteristics of objects as defined earlier in WT 3.4, as well as new, demonstrator-specific operations.

Input:

WT 2.1 – WT 2.8, WT 3.1 – WT 3.3

Output:

WT 4.1, WT 4.2

Approach:

- Define symbolic operations for WT 4.1
- Document the underlying symbolic conceptual model for the user
- Define analog operations for WT 4.2
- Document the underlying analog conceptual model for the user

Contributions:

NICI report; RUB report

WORK DESCRIPTION SHEET

ESPRIT BASIC RESEARCH Project 8579 MIAMI	WP No. 3	WT No. **3.8**

Task title: **Detection of action patterns** Partner responsible: UKA Start date: 01/07/95 End date: 31/08/95 Task manager: S. Münch Planned resources: UKA: 1.5 - RUB: 1 (in man-months) NICI: 1 - ICP: 2	Sheet 1 of 1 Issue date: 08/10/93

Objective:

To provide a mechanism for the detection and creation of action patterns in the user's multimodal input to the system. After the detection of (e. g. cyclic) user action patterns, the system has to trigger suitable responses and propose shortcuts (e.g., through automatic macro generation).

Input:

WT 2.1 – WT 2.8, WT 3.1 – WT 3.3

Output:

Report, Workshop

Approach:

- Providing a model of multimodal pattern interactions
- Suggesting conflict solutions in case of fuzzy or missing information
- Inferring possible user goals and proposing more efficient modalities
- Using machine learning techniques for the detection and macro generation (e. g. DBL – Dialogue-Based Learning)

Contributions:

UKA software and experiences from machine learning; RUB software support; NICI data clustering procedure

WORK DESCRIPTION SHEET

ESPRIT BASIC RESEARCH Project 8579 MIAMI	WP No. 4	WT No. **4.1.1**

Task title: **Adaptation of system architecture to the Symbolical demonstration (I)**

Partner responsible: RIIT

Start date: 01/09/95

End date: 31/12/95

Task manager: I. Defée

Planned resources: (in man-months) RIIT: 4 - NICI: 2 - RUB: 1.5 DIST: 3 - ICP: 1

Sheet 1 of 1

Issue date: 08/10/93

Objective:

Adaptation of the general system architecture developed in WP 3 to the one used in symbolic demonstrator

Input:

System architecture from WP 3

Output:

Design for the architecture of symbolic demonstrator

Approach:

- Design of a graphics module for "Information City"
- Design of an audio module for "Information City"
- Design of a control navigation interface with different modalities
- Design of an output interface for navigation support and guidance

Contributions:

RIIT design of graphics module, integration; NICI pen and gesture input adaptation; RUB design of audio module; DIST module for the reconstruction and movement of an antropomorphic figure in virtual space, including speech and music; ICP virtual face 'clerk' module, speech recognition interfacing

WORK DESCRIPTION SHEET

ESPRIT BASIC RESEARCH Project 8579 MIAMI	WP No. 4	WT No. **4.1.2**

Task title: **Hardware adaptation (I)** Partner responsible: RIIT Start date: 01/01/96 End date: 29/02/96 Task manager: I. Defée Planned resources: RIIT: 1 - NICI: 1 - RUB: 1 (in man-months) DIST: 1 - ICP: 1	Sheet 1 of 1 Issue date: 08/10/93

Objective:

Adaptation of hardware used by each partner in its domain for the symbolic demonstrator

Input:

Hardware used in the respective domain of each partner

Output:

A common platform for experiments

Approach:

- Specification of minimum hardware requirements
- Provision of common software tools
- Ensuring for compatibility

Contributions:

RIIT SUN platform support, integration; NICI pen digitizer integration; RUB audio device support; DIST display aspects, speech processing and sound generation; ICP virtual face 'clerk' display aspects, speech recognizer audio components

WORK DESCRIPTION SHEET

ESPRIT BASIC RESEARCH Project 8579 MIAMI	WP No. 4	WT No. **4.1.3**

Task title: **Software adaptation (I)**

Partner responsible: RIIT

Start date: 01/03/96

End date: 30/09/96

Task manager: I. Defée

Planned resources (in man-months): RIIT: 6 - NICI: 3 - RUB: 1 - DIST: 2 - ICP: 2

Sheet 1 of 1

Issue date: 08/10/93

Objective:

To adapt and extend software developed by each partner in WP3 for symbolic demonstrator

Input:

Software from WP 3, software developed by each partner

Output:

The *symbolic demonstrator*, a software system illustrating "Efficient Interaction and Manipulation Through Information Space Using Multimodality and Topological Modelling"
Deliverable 5

Approach:

- Integration of specific software modules into one demonstrator
- Demonstrating a prototype multimodal navigation through "Information City"

Contributions:

RIIT visual modality software, SUN platform integration; NICI pen gesture and cursive recognition; RUB auditory modality software; DIST integration of the software for the control of the antropomorphic figure and sound/music generation; ICP virtual face 'clerk' integration, speech recognition integration

WORK DESCRIPTION SHEET

ESPRIT BASIC RESEARCH Project 8579 MIAMI	WP No. 4	WT No. **4.2.1**

Task title: **Adaptation of system architecture to the Analog demonstration (II)** Partner responsible: UKA Start date: 01/09/95 End date: 29/02/96 Task manager: S. Münch Planned resources: UKA: 6 - DIST: 3 - RUB: 1.5 (in man-months) NICI: 2 - ICP: 1	Sheet 1 of 1 Issue date: 08/10/93

Objective:

The adaptation of the general system architecture developed in WP 3 to a concrete one which can be used as a basis for the implementation of the analogical demonstrator.

Input:

System architecture from WP 3

Output:

Conceptual design for the architecture of the analogical demonstrator
Deliverable 6

Approach:

- Designing the man-machine-interface for a teleoperation station using several input and output channels
- Selecting the hardware for input and output of data and actions, taking into consideration the results of the experiments of WP 2
- Developing data models, structures, and types for the implementation of the demonstrator

Contributions:

UKA design of robot-control-interface; RUB design of audio module; NICI,DIST modules for analog control by pen; ICP, DIST analog virtual face control

WORK DESCRIPTION SHEET

ESPRIT BASIC RESEARCH Project 8579 MIAMI	WP No. 4	WT No. **4.2.2**
Task title: **Hardware adaptation (II)** Partner responsible: UKA Start date: 01/03/96 End date: 30/04/96 Task manager: S. Münch Planned resources: UKA: 2 - RUB: 1 (in man-months) NICI: 1 - ICP: 1		Sheet 1 of 1 Issue date: 08/10/93

Objective:

The adaptation of the hardware used by each partner in their respective domains and used during WP 3 in this project to the analogical demonstrator.

Input:

Hardware used in the respective domains of each partner and in WP 3

Output:

A common hardware platform for the experiments shown in the analogical demonstrator
Deliverable 6

Approach:

- Integration of several hardware modules used for the bimodal experiments in WP 2
- Integration of different hardware modules used in the respective domains of each partner

Contributions:

UKA robot, telemanipulation station, graphic workstation; RUB audio device support; NICI digitizer integration; ICP analog virtual face control & display aspects

WORK DESCRIPTION SHEET

ESPRIT BASIC RESEARCH Project 8579 MIAMI	WP No. 4	WT No. **4.2.3**
Task title: **Software adaptation (II)** Partner responsible: UKA Start date: 01/04/96 End date: 30/09/96 Task manager: S. Münch Planned resources: UKA: 6 - DIST: 2 - RUB: 1 (in man-months) NICI: 3 - ICP: 2		Sheet 1 of 1 Issue date: 08/10/93

Objective:

The adaptation of the software used by each partner in their respective domains and the software developed during WP 3 in this project to the analogical demonstrator.

Input:

Software from WP 3, software used in the respective domains of each partner

Output:

The *analogical demonstrator*, a software system to show "Efficient Interaction and Manipulation Through Information Space Using Multimodality, Geometry and Time" Deliverable 6

Approach:

- Integration of several software modules and libraries into one demonstration system
- Realization of a prototype system to demonstrate the advantages of a multimodal approach in teleoperation systems

Contributions:

UKA software for the planning and control of robot and telemanipulation operations; RUB auditory modality software; NICI, DIST pen-controlled navigation and object handling; ICP, DIST analog virtual face control integration

WORK DESCRIPTION SHEET

ESPRIT BASIC RESEARCH Project 8579 MIAMI	WP No. 4	WT No. **4.3.1**
Task title: **Definition of evaluation criteria** Partner responsible: NICI Start date: 01/08/96 End date: 31/08/96 Task manager: L. Schomaker Planned resources: NICI: 1 - RUB: 1 (in man-months)		Sheet 1 of 1 Issue date: 08/10/93

Objective:

To define the evaluation procedure for the two demonstration setups, using accepted guidelines from cognitive ergonomics studies, experimental psychology studies and psychophysical studies.

Input:

WT 4.1.1 – 4.1.2, WT 4.2.1 – 4.2.2

Output:

WT 4.3.2

Approach:

- Defining the experimental protocol
- Defining the relevant unimodal, bimodal or multimodal conditions
- Defining dependent variables
- Defining analysis methods
- Defining evaluation criteria

Contributions:

NICI report; RUB psychophysics expertise

WORK DESCRIPTION SHEET

ESPRIT BASIC RESEARCH Project 8579 MIAMI	WP No. 4	WT No. **4.3.2**

Task title: **Usability experiments with human subjects** Partner responsible: RUB Start date: 01/10/96 End date: 31/12/96 Task manager: K. Hartung Planned resources: RUB: 4 - NICI: 2 - DIST: 3 - (in man-months) ICP: 3 - RIIT: 1 - UKA: 1	Sheet 1 of 1 Issue date: 08/10/93

Objective:

To provide preliminary usability data for future research and application development.

Input:

WT 4.1.1 – 4.1.3, WT 4.2.1 – 4.2.3, WT 4.3.1

Output:

Future research

Approach:

- Test and evaluation of object interaction and manipulation in teleoperation using unimodal and multimodal input and output channels)
- Test and evaluation of multimedia information retrieval using multimodal navigation in the "Information City"

Contributions:

ALL experiment, report

II.3 Milestones, Deliverables and Reviews

In the **MIAMI** project, three *MILESTONES* have been defined which will show the progress of work after the 1st, the 2nd, and the 3rd year of the project. These milestones are:

M1: a *Review Meeting* in the end of 1994, where the consortium will present a report of its work. This meeting will take place after Workpart 2 is finished;

M2: a *Workshop* to present the results of Workpart 3 to a broader public, in connection with a review meeting. The software tools developed so far will be shown to demonstrate the approach and the ongoing progress; and

M3: another *Workshop* together with the final review meeting at the end of the project (1996) where the two demonstrators will underline the advantages of multimodal integration in their respective application areas.

All *DELIVERABLES* will be shown in more details on the next pages.
The following list will give a brief overview:

D1: Software Tools for Multimodal Experiments *(after WP 1)*

D2: Progress Report *(after WP 2)*

D3: Basic Software Architecture *(after WT 3.3)*

D4: Completed Software Architecture *(after WP 3)*

D5: Symbolical Demonstrator *(after WP 4)*

D6: Analogical Demonstrator *(after WP 4)*

D7: Evaluation Report *(after WP 4)*

The following table indicates the relation between *Milestones* and *Deliverables*:

Milestone	Deliverables
M1	D1, D2
M2	D3, D4
M3	D5, D6, D7

Table 2: Schedule of Deliverables

DELIVERABLE DESCRIPTION SHEET

ESPRIT BASIC RESEARCH Project 8579 MIAMI	Deliverable No. 1
Name of deliverable: **Common Software Tools for Multimodal Experiments** Partner responsible: NICI Date of delivery: 31/08/94 Status of deliverable: Public	Sheet 1 of 1 Issue date: 08/10/93

Technical description:

On the basis of the common environment (SUN/Xwindow system) a library is developed for rendering polyhedrons and dynamically controlling their parameters in real time. This basic platform allows for the execution of the bimodal experiments under highly comparable conditions for the different bimodal experiments. The library will be written in C/C++.

Future use:

Will be used in most work tasks of WP 2 and will provide a starting point for the architecture design in WP 3

Form of presentation:

Documentation, dissemination of source code among partners

DELIVERABLE DESCRIPTION SHEET

ESPRIT BASIC RESEARCH Project 8579 MIAMI	Deliverable No. 2
Name of deliverable: **Progress Report** Partner responsible: NICI Date of delivery: 31/12/94 Status of deliverable: Public	Sheet 1 of 1 Issue date: 08/10/93

Technical description:

Experimental results after Workpart 2

Future use:

Information dissemination on conferences, workshops, etc.
The results are used as a basis for the work that follows in Workpart 3 and Workpart 4 within this project

Form of presentation:

Report

DELIVERABLE DESCRIPTION SHEET

ESPRIT BASIC RESEARCH Project 8579 MIAMI	Deliverable No. 3
Name of deliverable: **Basic Software Architecture** Partner responsible: NICI Date of delivery: 31/05/95 Status of deliverable: Public	Sheet 1 of 1 Issue date: 08/10/93

Technical description:

A functional and architectural definition of the basic components of the demonstrators I and II. The definition of the software is based on an extension and elaboration of the developments in WP 1 and WP 2.

Future use:

The results are used as a basis for the work that follows in Worktasks 3.4 – 3.8 in Workpart 3 and in Workpart 4 within this project

Form of presentation:

Report

DELIVERABLE DESCRIPTION SHEET

ESPRIT BASIC RESEARCH Project 8579 MIAMI	Deliverable No. 4
Name of deliverable: **Completed Software Architecture** Partner responsible: NICI Date of delivery: 31/12/95 Status of deliverable: Restricted	Sheet 1 of 1 Issue date: 08/10/93

Technical description:

Software architecture for the integration of two or more modalities within a multimedia application. Components of the system may originate from earlier projects with restrictions on the availability.

Future use:

The developed architecture will serve as a basis for the design of the two demonstrator systems which will be shown in the end of the project.

Form of presentation:

Report
Demonstration to the Commission and the Public at a Workshop

DELIVERABLE DESCRIPTION SHEET

ESPRIT BASIC RESEARCH Project 8579 MIAMI	Deliverable No. 5
Name of deliverable: **Symbolical Demonstrator** Partner responsible: RIIT Date of delivery: 31/12/96 Status of deliverable: Restricted	Sheet 1 of 1 Issue date: 08/10/93

Technical description:

The Symbolical Demonstrator has been chosen to show the benefit of multimodal integration in the context of managing complexities of information spaces. The demonstrator scenario is using "Information City" metaphore and free navigation (using multimodal input for control and output for guidance) throughout the "City" as efficient means for multimedia information retrieval.

Future use:

Information dissemination at conferences, workshops, journals, theses, etc.

Form of presentation:

Demonstration of "Efficient Navigation Through Information Space Using Multimodality and Topological Modeling" to the Commission and the Public at a Workshop in combination with a review meeting

DELIVERABLE DESCRIPTION SHEET

ESPRIT BASIC RESEARCH Project 8579 MIAMI	Deliverable No. 6
Name of deliverable: **Analogical Demonstrator** Partner responsible: UKA Date of delivery: 31/12/96 Status of deliverable: Restricted	Sheet 1 of 1 Issue date: 08/10/93

Technical description:

The Analogical Demonstrator has been chosen to show the benefits of multimodal integration in the context of object interaction and manipulation. The scenario consists of a teleoperation station in which the advantages of using more than one mode for the interaction with the system can be seen very clearly. The demonstration will cover among other things:

- Manipulation of virtual and real objects: multimodal expression and sound/music output in a virtual humanoid
- Telemanipulation and mobile robot guidance: development of a vocabulary of basic movements executable by a mobile robot, its integration with sound/music and facial outputs, and its use in a real context

The exact form of the demonstration will, of course, emerge more clearly during the project and can not be described in more detail until the end of the second year.

Future use:

Information dissemination on conferences, workshops, in journals, theses, etc.

Form of presentation:

Demonstration of "Efficient Interaction and Manipulation Through Information Space Using Multimodality, Geometry and Time" to the Commission and the Public at a Workshop in combination with a review meeting

DELIVERABLE DESCRIPTION SHEET

ESPRIT BASIC RESEARCH Project 8579 MIAMI	Deliverable No. 7
Name of deliverable: **Evaluation Report** Partner responsible: NICI Date of delivery: 31/12/96 Status of deliverable: Public	Sheet 1 of 1 Issue date: 08/10/93

Technical description:

Experimental results of usability experiments with human subjects

Future use:

Information dissemination on conferences, workshops, etc.
Stimulation of future research
Database for application development

Form of presentation:

Report
optionally: Book, Workshop Proceedings

II.4 Project Management

II.4.1 Responsibility and Problem Intervention

Workparts are subdivided in Work Tasks. Each Work Task is executed by a Task Group, under the guidance of the Task Leader. It is the responsibility of the Task Leaders (1) to organize the initiation of the Work Task at the planned starting point in time, (2) to ensure the efficient and complete acceptance of results from related earlier related Work Tasks, (3) to ensure seamless transferral of knowledge to dependent Work Tasks, even if this involves unforeseen but manageable revisions, (4) to ensure clarity within the Work Group with respect to the Work Task objectives. The Project Coordinator will keep track of the forthcoming state transitions and announce them in advance to the Task Leaders, who will in turn organize the relevant new Task Group.

Problems within a Task Group, leading to risks of not meeting deadlines or completing deliverables should be mentioned to the Project Coordinator using open communication to all the partners concerned, preferably by paper mail, at the earliest possible stage.

For the last year (WP 4), two Task Coordinators are appointed for the two demonstrators. The Task Coordinators will report to the Project Coordinator the status of the development of the final deliverables of MIAMI. Because the Task Coordinator is also Task Leader in all the tasks involved in a demonstrator, the communication overhead in minimized in this critical stage.

II.4.2 Task Management and Project Coordination

Task Leaders

WT	Short title	Task Leader
2.1	Visual-Acoustical	RUB
2.2	Visual-Speech	ICP
2.3	Visual-Gestural	DIST
2.4	Handwriting-Visual	NICI
2.5	Handwriting-Speech	NICI
2.6	Visuo-Motoric	UKA
2.7	Cognitive-Acoustic	RUB
2.8	Dissemination	NICI
3.1	Input Channels	NICI
3.2	Output Channels	RUB
3.3	Object Space	UKA
3.4	Object Generation	NICI
3.5	Navigation	RIIT
3.6	Interaction	UKA
3.7	Allowable operations	NICI
3.8	Action Patterns	UKA
4.1	Symbolical Demo	RIIT (Task Coordinator)
4.1.1	Architecture	RIIT
4.1.2	Hardware	RIIT
4.1.3	Software	RIIT
4.2	Analog Demo	UKA (Task Coordinator)
4.2.1	Architecture	UKA
4.2.2	Hardware	UKA
4.2.3	Software	UKA
4.3	Evaluation	
4.3.1	Criteria	NICI
4.3.2	Experiment	RUB

Each Task Leader (i.e., each project partner leading a specific Worktask) has appointed a local person to do the actual task management: the Task Manager. The Task Manager is mentioned on each Work Description Sheet describing the Worktasks.

Task Managers

NICI	Dr. Lambert Schomaker
DIST	Dr. Antonio Camurri
ICP	Dr. Christian Benoit
RIIT	Dr. Irek Defée
UKA	Dipl.-Inform. Stefan Münch
RUB	Dipl.-Ing. Klaus Hartung

In case of undue problems, leading to risks of not completing deliverables, the consortium will organize a meeting. Partners will provide for an early announcement of changes in key personnel to the Project Coordinator.

The Project Coordinator will dedicate 2 manmonths per year for communication with the Commission, the handling of official correspondence and will take care for the handling of reports and deliverables.

The Project Coordinator will organize the creation of a Workshop Committee, one for each of the two Workshops which will be held.

All partners will have a Local Project Manager. The Local Project Manager will locally appoint a person to handle the MIAMI-relevant communication during his absence, and will inform the rest of the consortium of this, as well as mentioning the communication channel(s) which still can be used.

General Project Manager

Dr. Lambert Schomaker

Local Project Managers

NICI	Dr. Lambert Schomaker
DIST	Dr. Antonio Camurri
ICP	Dr. Christian Benoit
RIIT	Dr. Irek Defée
UKA	Prof. Dr.-Ing. Rüdiger Dillmann
RUB	Prof. Dr.-Ing. Jens Blauert

II.4.3 Brief CV of Local Project Managers

Lambert Schomaker (NICI, Nijmegen, The Netherlands)

L.R.B. Schomaker (1957) received his Masters degree in psychophysiological psychology in 1983, and his Ph.D. degree on "Simulation and Recognition of Handwriting Movements" in 1991 at Nijmegen University, The Netherlands. Since 1988, he has been working in two ESPRIT projects concerning the recognition of on-line, connected cursive script on the basis of psychomotor models of handwriting movement. He is currently the project manager for three industry-sponsored projects, as well as local project manager within an AIM project. Further duties involve teaching and Master's Thesis coaching.

His research interests are human movement control and robotics, and connectionist models for simulating motor processes and recognizing temporal patterns. Of special interest are oscillator-based neural networks. Work in recent years focusses on the recognition of on-line cursive handwriting using neural network models. He has been involved in the organization of handwriting conferences on computer recognition and on computer analysis and modeling of handwriting. Within the IAPR, Dr. Schomaker is the vice-chairman of a committee founded by the TC11 for the development of an international data base of on-line handwriting samples (SCRIPSIT). Furthermore, he has contributed to 45 reviewed publications in journals and books and has reported on research results in 21 international workshops and conferences.

Christian Benoit (ICP, Grenoble, France)

Christian Benoit obtained his degree in Electronics at the Polytechnic National Institute of Grenoble in 1980. He then spent two years teaching Physics in Morocco before preparing a doctoral thesis at the Institute of Phonetics in Grenoble, on the temporal organization in speech production (1985). He then joined the Department of Speech Communication at the CNET, in Lannion, where he worked on speech synthesis and on its assessment.

Since 1988, he has a permanent position at the CNRS (National Center for Scientific Research), and he works at the ICP, in Grenoble, where he leads the Speech Synthesis Group. He has been an active member of the Bureau of the French Speech Group since from 1987 to 1992. He participated for five years in the ESPRIT project SAM, on cross-linguistic standard procedures for the assessment of synthetic speech. He was the organizer of the First Franco-British Meeting on Speech, held in Lannion in 1987. He was the Chairman of the European Tutorial Day and Research Workshop on Speech Synthesis, held in Autrans (France), in September 1990, on behalf of the ESCA (European Speech Communication Association). He is the co-editor of the book Talking Machines: Theories, Models and Designs, published in 1992 by Elsevier.

His main areas of research involve the intelligibility of natural and synthetic speech, the bimodal aspects of speech production and perception, and the synthesis of talking faces. Within the last two years, he authored (or coauthored) two articles in international journals, two articles in national journals, two articles in a book, and 11 papers published in the Proceedings of Conferences with Reviewing Committee.

Antonio Camurri, (DIST, Genova, Italy)

Antonio Camurri was born in Genoa, Italy, in 1959. He received a Degree in Electrical Engineering in 1984, and the PhD in Computer Engineering in 1989 from the University of Genoa. He performed formal musical studies at the music conservatories of Genoa and Parma. Currently, Antonio Camurri is a research computer scientist at the Department of Communication, Computer and System Sciences (DIST) of the University of Genoa, and collaborates with the Computer Music Lab of the University of Milan.

His research interests include Artificial Intelligence, Petri nets, and models of representation of music and multimedia knowledge. He is member of the Board of Directors of AIMI (Italian Computer Music Association), founding member of the Italian Association for Artificial Intelligence (AI*IA), member of the Executive Committee of the IEEE Task Force on Computer Generated Music, and of the Advisory Board on the international journal Interface. He is also member of IEEE and of the IEEE Task Force on Multimedia Computing.

Irek Defée (RIIT, Tampere, Finland)

Irek Defée was born in Poland in 1949. He is Polish citizen, permanent resident of Finland. He received M.S. degree in Electrical Engineering in 1973, M.S. degree in mathematics in 1977, and Ph.D. degree in applied mathematics in the area of cellular automata, in 1979. He was an assistant in 1973–1979, and assistant professor at the Technical University of Szczecin, Poland from 1979. In 1983 he spent half a year at the Delft University of Technology, Holland, and in 1984–85 he was a visiting researcher at the Tampere University of Technology in Finland. In 1987–89 he was a researcher, and in 1989–91 an associate professor in the Signal Processing Laboratory, Tampere University of Technology. From 1991 he is a senior researcher at the Research Institute of Information Technology.

His main interests are in the area of image and video processing and multimedia and he is an author of about 30 publications. He organized several international courses on HDTV, and he was responsible for activities related to ESPRIT and RACE. At present he is the project leader within the RACE project 2056 AMICS (Advanced Multimedia Image Communications and Services).

Rüdiger Dillmann (UKA, Karlsruhe, Germany)

Prof. Dr.-Ing. Rüdiger Dillmann was born in Mannheim, Germany, in 1949. He studied Electrical Engineering with the emphasis on Biocybernetics from 1970 to 1976 and obtained his Diploma Degree in 1976. In the following, he was research associate at the Department of Computer Science at the University of Karlsruhe until 1981. He obtained his doctoral degree in 1980.

From 1980 to 1986, Prof. Dillmann was research assistant professor at the Institute for Real-Time Computer Systems and Robotics at the University of Karlsruhe. In 1986 he did his habilitation in computer science with the topic of machine learning techniques for autonomous robots. Since 1987 he has been university professor for computer science and is director of the CAD/CAM/Robotics group at the Institute for Real Time Computer Systems and Robotics. He is also the head of the "Interactive techniques for planning" research group at the FZI Karlsruhe.

His fields of interest cover Robotics in general and several special topics with emphasis on the field of intelligent robot systems, such as robot system architectures, autonomous systems, the application of machine learning mechanisms to robot systems. Additionally, Mr. Dillmann is very engaged in the field of integration of CAD/CAM, robotics, and simulation techniques. Mr. Dillmann is author or co-author of over 60 scientific papers and has written three books on robotics and machine learning. He has done three editorials on CIM systems, advanced robotics and knowledge-based systems and has edited five conference reports. He is member of CIM-Europe TC-7 "Advanced Robotics" and speaker (resp. sub-speaker) of the German GI-Fachgruppe 4.0.1 (resp. 1.0.3) "Robotersysteme". He has participated in several ESPRIT projects in the areas of CIM and robotics before and is currently engaged in the BLEARN II project (ESPRIT BRA No. 7274).

Jens Blauert (RUB, Bochum, Germany)

Jens Blauert was born in 1938. He studied communication engineering at Aachen, where he received a Doctor of Engineering degree in 1969. In 1973, he delivered an inaugural dissertation to the Technical University in Berlin. Since 1974 he holds the chair in electrical engineering and acoustics at the Ruhr-Universitaet at Bochum. He is a professional acoustical consultant.

He is the author of more than 70 papers and monographs and holds several patents. A former chairman of the ITG committee on electroacoustics, Dean of the Faculty of Electrical Engineering at Bochum and Senator of the Ruhr-Universitaet, he is a member of the Environmental Protection Council of the State of North-Rhine Westphalia and board member and committee chairman for the German Standard Association (DIN). He is a cofounder and board member of both the German Acoustical Society (DEGA) and the European Speech- Communication Association (ESCA), a Fellow of ASA, a Senior

Member of IEEE and the Speaker of a Bochum-based research consortium, Telepresence, with 36 full-time scientist involved.

His current fields of interest include: external and middle ear physics, application of dummy heads for recording and measuring purposes, binaural technology, spatial hearing, models of binaural hearing, auditory virtual environment and telepresence, architectural acoustics, noise engineering and speech technology (synthesis, enhancement, recognition and assessment). He has supervised various projects concerning synthesis by rule from text, speech recognition and speech quality evaluation. He leads the German group in ESPRIT project 291/380 "Linguistic Analysis of the European Languages".

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