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Fuzzy Inference Mechanism Based Approach for Multi-Dimensional Sequential Web Mining

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Abstract

There are several applications of sequential web mining, which is used to find the frequent subsequences in a web log in the World Wide Web (the web). We implemented a tool to analyze the sequential behavior of web log access patterns in multiple-dimensions. Sequences of frequent access patterns may change temporally and spatially. Based on the specified criteria like year, month, day, hours and location, the end-user is able to tune the minimum support threshold parameter intuitively using the fuzzy inference mechanism. Domain experts are can access several criteria, including minimum support threshold and number of accesses according to the user intuition, which is later, transformed into fuzzy inference parameters. We propose two different types of rule bases by considering the (support-minimum support, minimum support) and (support, minimum support), i.e., interval and case-based. To test our proposal, we used the web log dataset of the Department of Computer at the University of Calgary to analyze sequential access patterns of students during February and March carried out in the campus by taking the midterm dates into account. The results reported in this paper are promising; they demonstrate the applicability and effectiveness of the proposed approach.

1. Introduction

Data Mining is the notion of all methods and techniques that allow analyzing very large data sets to extract and discover previously unknown structures and relations out of such huge heaps of details. The information is filtered, prepared and classified so that it will be a valuable aid for decisions and strategies [1]. The web contains close to 350 million web pages and its daily growth rate is around one million web pages [2]. With the huge amount of information available online, the web is a fertile area for data mining research. This shows the necessity for analyzing and discovering the web. Web mining appears to be the crossroad of research from several communities, including the database information retrieval within AI and especially the sub-areas of machine learning and natural language processing [3]. Web mining is mining from web repositories. Its main tasks are defined as web structure, web content and web usage mining. Web content mining is related to the discovery of useful information from web content, data, documents and services, whereas web structure mining is to mining the structure of hyperlinks within the web itself (inter-document structure is used instead of web content mining, which is relevant to intra document structure). Web usage mining mines secondary data generated by users' interaction with the web. Web usage data includes data from web server access logs, proxy server logs, browser logs, user profiles, registration files, user sessions or transactions, user queries, bookmark folders, mouse-clicks and scrolls, and any other data generated from users access to the web [4]. Web usage mining process has three main steps: data preparation, pattern discovery, and pattern analysis phases [6].

Sequential pattern mining was first introduced by Aggrawal and Srikant (AprioriAll) [5]. It discovers and analyzes the frequent patterns in a sequence database. Thus, by mining frequent sequential patterns ordered correlations, we get remarkable sequences not necessarily adjacent to each other [5, 8-11,13-19]. Sequential pattern mining may be defined as follows: given a collection of transactions ordered in time and each transaction contains a set of items, the goal is to find sequences of maximal length with support above a user-specified threshold. A sequence is an ordered list of elements, an element being a set of items appearing together in a transaction. Elements do not need to be adjacent in time, but their ordering in a sequence must follow the time ordering of the supporting transactions [7]. Finally, sequential rule mining may contain different types of constraints [20].

Web access pattern is a sequential pattern in a large set of accesses, namely web log. Log analysis is the first step in Web usage mining. Several commercial and shareware systems exist for the log\traffic analysis, and the majority of them are statistical reports, e.g., Analog,WebLogs, WebLog, Ststat, Follow 2, and WUM, which can be characterized rather as a sequence miner [21]. Other type of applications include: to cluster user groups to analyze their navigational patterns and discover some correlations between them or correlations between the web pages and the users for recommendation and personalization purposes in adaptive or non-adaptive manner [22].

Many frequent patterns will be related to time and location due to the changing environment of web sites and user profiles accessing them. This is also valid for several different applications like customer behavior, stock market fluctuations, etc. Using the multi-dimensional information related to web accesses will be

Searching the World-Wide-Web with Learning Agents

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***Abstract*—Present day search engines are far from perfect because they retrieve a great number of pages from different sources (reliable or not), and because they sometimes return unexpected results. The search results would improve if the search engine knew a set of reliable sites where we are expecting to find good results. We propose a server-side multi agent system that addresses search problems like source reliability, time-constrains and reducing the complexity. The agents learn degrees of confidence for some sites of interest, starting from a limited number of domains known as trustworthy and updating them from future search results. These degrees of confidence are used to select where to search next, considering that we are expecting to find more promising results on the sites with a higher confidence degree. Using input from the user, these degrees are updated with every new search.**

Keywords: agents, web search, confidence, preferences

I. Introduction

The search process can be analyzed from different perspectives: what to look for, where to look, how to evaluate the likelihood that a page is a good result.

Searching the web for relevant and trustworthy information is not an easy task. The number of pages retrieved is very large, they are not always what the user was looking for, and they are often unreliable. Searching only by keywords may not always be suitable for the huge amount of information on the Web. Research in the area is trying to improve the search process so that a small number of good results from reliable sources is returned.

Because of the quantity of information available on the Internet, finding something specific can be quite a headache. This was the motivation behind the numerous search engines used today. However, searching through the entire web can be a difficult task. Most of the problems encountered are related to complexity and reliability. Therefore, the results returned by the search engines are sometimes unsatisfactory, due to both their big number and their unexpected content. Also, one rarely really wants to search through all the various topics debated on the web. These are the main reasons extra processing of the search results is necessary for better information retrieval performance. Possible approaches include: *Web Mining* - extracting useful information from the set containing all the pages on the Web; *Classification of Web Pages* - grouping similar pages is done either manually or automatically; *Building a Knowledge Base* - mirroring the contents of the World Wide Web; *Using Learning Algorithms*; *The Semantic Web* - an extension of the current Web, with support for databases in machine-readable form; *Relying on Trust and Reputation*; *Creating User Profiles*.

A significant amount of effort is being deployed to enable more effective retrieval of Web information, as well as new uses of the Web to support knowledge-based inference and problem solving [1].

The need to evaluate user reactions when using autonomous agents to assist with information centric tasks on the Semantic Web gave birth to *Nuin*, an agent platform that was designed for practical development of agents in Semantic Web applications, based around belief-desire-intention (BDI) principles [2].

One first approach to make the retrieval of Web information more efficient is to rank the pages based on their relevance to a specific user, using contextual information. The personalization of the search engine can be made using a short-time user profile constructed by a client-side application that captures current user activities. This approach has the advantage that the user is not directly asked for information, but the contextual information allows ranking of results. [3]

Another approach is to learn hypertext classifiers by combining a statistical text-learning method with a relational rule learner. The statistical component allows text characterization in terms of word frequencies, and the relational component describes how neighboring documents are related to each other by the hyper-

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Web Mining with Self-Organizing Maps

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***Abstract* – The self-organizing map (SOM) is a data mining and visualization method for complex high dimensional data sets. We have applied the SOM model in Web mining, by giving sets of documents as input data space for SOM. The result of applying SOM on a set of documents is a map of documents, which is organized in a meaningful manner so that documents with similar content appear at nearby locations on the two-dimensional map display. From the information retrieval point of view, our implemented SOM-based system creates document maps that are readily organized for browsing. A document map also clusters the data, resulting in an approximate model of the data distribution in the high dimensional document space. The paper describes some promising experimental results, where a couple of meaningful clusters have been discovered by our system in a subset of the "20 newsgroups" data set. The clustering capability of our system allows users to find out quickly what is new in a Web site of interest by comparing the clusters obtained from the site at different moments in time.**

I. INTRODUCTION

The self-organizing map (SOM) is a very popular unsupervised neural network model for the analysis of high dimensional input data [7]. It is a clustering, visualization and abstraction method based on displaying the data set in another, more usable representation form. SOM allows mapping the high dimensional input data onto a two-dimensional output space. The resulting map is a two-dimensional grid of arrays, which preserves the structure of the input data as faithfully as possible: data items close to each other in the high dimensional data space are close to each other on the map. The main advantage of the self-organizing maps is that large quantities of data can be organized quickly into a compact form that reveals the structure within the data. As such, a SOM map displays an overview of the data.

A somehow non-classical approach in the mining of Web documents is the one based on the self-organizing maps [4, 7]. The method is applicable to any collection of (hyper) text documents and is especially suitable when the user has rather limited knowledge about the domain or the contents of the text collection. Our implemented SOM-based system manages a large collection of HTML documents by spreading them on a SOM map. Semantically similar documents occupy the same position or neighbor positions on the map, depending on the degree of semantic content similarity. The system allows the user to navigate on the document map, in order to retrieve relevant documents from different topics.

We will also show that our self-organizing maps are also capable of finding semantically meaningful clusters on a map of documents. By a cluster in a SOM map we mean a contiguous group of neurons in an area of the map where all the neurons contain similar data items (for instance, documents similar in content on a document map). The cluster visualization capability is based on applying the unified-distance matrix (U-matrix) algorithm on a SOM map [3, 13, 14]. The flat clusters can be visually discovered with the help of different grey-levels on the map as induced by the U-matrix algorithm. Our experimental results from clustering documents are encouraging.

II. SELF-ORGANIZING MAPS

The self-organizing maps have been created by Teuvo Kohonen as a particular kind of neural networks [7]. There are multiple views on SOM; the different definitions are the following. SOM is a model of specific aspects of biological neural nets (the ordered "maps" in the cortex). SOM is a model of unsupervised machine learning and an adaptive knowledge representation scheme. SOM is a tool for statistical analysis and visualization: it is both a projection method which maps a high dimensional data space into a lower dimensional one and a clustering method so that similar data samples – represented as vectors of numerical attribute values – tend to be mapped on nearby neurons. The resulting lower dimensional output space is a two-dimensional grid of arrays (the SOM map) which visualizes important relationships among the data, – which are latent in the input data set – in an easily understandable way. This dimensionality reduction maintains the topology of the input vectors, i.e. inputs that are close to each other – in other words, similar – in the input space are also close to each other in one of the clusters of the map.

In short, SOM is a data mining and visualization method for complex high dimensional data sets. Even though there are no explicit clusters in the input data set, important relationships are nevertheless latent in the data. SOM can discover and illustrate these latent structures of an arbitrary data set. SOM can describe different aspects of a phenomenon in any domain, provided that the data in the domain can be represented by vectors of numerical attributes.

The map learns by a self-organization process. No a priori knowledge about the membership of any input data item (vector) in a particular class or about the number of such classes is available. Hence, the training proceeds with unlabeled input data like any unsupervised learning. The clusters (classes) are instead discovered and described with gradually detected characteristics during the training process.

High-Level Robot Programming in a PC-Based Control Environment

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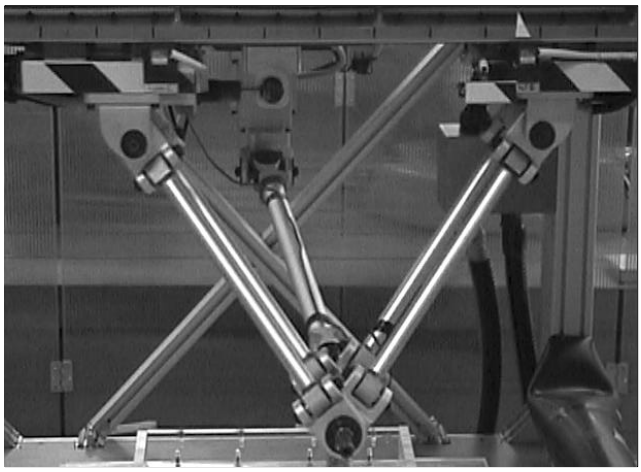

Fig. 1. The 4 d.o.f. PKM used as a testbed for the control

***Abstract* – In the last few years, the wide availability of computing power and operating systems with real-time capabilities offered the chance to develop low-cost PC-based solutions for motion control; this made possible to overcome limits in commercial robot controllers for their use in a research context. Moreover, modern scripting languages are becoming more and more powerful. High-level programming permits to easy write code in a smart way and does not require particular skills. In this paper we present the design of a modular architecture for PC-Based robot control under the QNX Real Time operating system. The proposed architecture allowed to use the Python programming language as an high-level object oriented scripting tool to program robot motions and to monitor, even remotely, the system. The designed architecture has been employed for the motion control of a 4 d.o.f. reconfigurable parallel robot, and the advantages deriving from the use of a high-level object-oriented robot programming language are shown through the programming of a demonstrative assembling cell of a manufacturing plant.**

I. INTRODUCTION

Nowadays industrial companies have to face frequent and unpredictable market changes. So, to remain competitive, companies must possess a new type of production system and intelligent machines able to react to such changes.

A limit for a broader employment of robots in this context is represented by the use of proprietary hardware, closed software architectures and communication protocols implemented by the robot manufacturers. In particular commercial robot controllers are programmable via their own procedural languages that run on proprietary hardwares. This feature limits the possibility to extend the robot capabilities, and the implementation of advanced sensing capabilities, as force control or vision systems, is not a trivial task. In the last years the wide availability of low cost computing power, interface cards for data acquisition and operating systems with real-time capabilities made, in the last decade, PC-based solutions for robot motion control feasible [1]–[6].

Beside universities and research laboratories, even the industrial world of numerical control manufacturers is looking with interest to PC-based solutions as demonstrated by their membership in research consortia aimed at the purpose of proposing standards for open architecture controllers: OSACA[1], OMAC[2], OSEC[3] and OROCOS[4], [7].

Despite the efforts that have been put so far, no widely recognized standards arose, neither in terms of reference architectures nor in terms of software tools (operating systems and programming languages).

Moreover, scripting languages are growing in popularity inside the programmers' community and their characteristics makes programming more and more simple; their diffusion is increasing in the computer world, but their adoption in the industrial world is at the beginning. Nowadays robot programming is still related to elementary structures and limited by low level structures and functions. Despite programming easiness and high-level characteristics of modern scripting languages, they are not yet used to program robot, excluding a few examples [8]–[10]. In our research we evaluated the programming features of different scripting languages; finally our choice has been in favour of Python [11]. In this work we exploit the benefits deriving from object-oriented design, very high-level structures and rich libraries, some of Python key features [12], [13].

In this paper we analyze how the Python programming environment has been developed and interfaced with a PC-based control system, whose core is a QNX real-time platform programmed through C++ code.

The designed solution has been applied for the motion control of a novel 4 d.o.f. reconfigurable parallel kinematic machine, thus exploiting the benefits deriving from the defined modular control architecture [14].

The work is organized as follows: Section *II* illustrates a general high-level overview of the control system, in Section *III* the correspondent software implementation is detailed with reference to the QNX4 operating system, in Section *IV* the use of Python in the programming and monitoring functionalities of the system is explained and a demonstrative application of the Python-based programming system is reported in Section *VII*.

Finally, conclusions and future works are drawn in Section *VIII*.

[1] Open System Architecture for Controls within Automation systems
[2] Open Modular Architecture Controller
[3] Open System Environment for Controllers
[4] Open RObot COntrol Software

A Low Cost Solution for the Navigation Problem of Wheeled Mobile Robots in Intelligent Space

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***Abstract* – The paper deals with the development of low cost PI-fuzzy controllers (PI-FCs) used as tracking controllers for nonholonomic mobile robots operating in the Intelligent Space. A simplified dynamic model of the wheeled mobile robots with two degrees of freedom is first proposed, operating in a cascaded control system structure with two control loops. The PI-FCs are considered as a special class of two degree-of-freedom controllers. There is proposed also a development method dedicated to the PI-FCs starting from the basic linear PI controllers by employing the Extended Symmetrical Optimum method. There are derived sensitivity models with respect to the parametric variations of the controlled plant. Simulation results validate the proposed fuzzy controllers.**

I. INTRODUCTION

Although there have been achieved great progresses, mobile robots which are capable of performing various and complex tasks in an autonomous and intelligent way, have not yet been able to conquer widespread applications. Therefore, it is important to develop high performance controllers to cope with the three basic navigation problems [1], tracking control (tracking a reference trajectory), path following and point stabilization. The tracking control problem can be further divided in the local and global tracking problems [2]. These control problems belong to the general class of controlling nonsmooth or nonholonomic systems [3], [4]. The control of nonholonomic mobile robots has received much research interest during the past years (see, for example, the overview presented in [3]) due to the implications of the nonholonomic constraints on the admissible control inputs for this class of systems.

The majority of controllers developed for nonholonomic mobile robots is based on kinematic or dynamic models [5], [6]. But, the dynamic models do not exploit the dynamics of the actuators, of the measuring devices and of the control equipment as part of the control system (abbreviated as CS). This comes to the first aim of the paper, the proposal of a simplified dynamic model that can characterize well the wheeled mobile robots with two degrees of freedom.

The current approaches to solving tracking control problems include general nonlinear techniques [7] with the backstepping as part of them [2], [4], the sliding mode approach [5], linear model or passivity based approaches [8], [9], the control Lyapunov function approach [10]. Some efforts regarding the application of sliding mode control have been reported [11], [12]. Since the development of the controllers based on these approaches is rather complex, it is necessary to simplify the controller development and further implementation. This will result in the second aim of this paper, to offer a development method for the PI-fuzzy controllers (PI-FCs) as a special class of the general class of two degree-of-freedom (2-DOF) controllers, used as tracking controllers. The development method is based on applying the Extended Symmetrical Optimum (ESO) method [13] to the basic linear PI controllers and by adding nonlinear features to the strictly speaking fuzzy blocks to improve the CS performance.

The CS proposed here to solve the tracking control problem contains two control loops for controlling the forward velocity and the angle between the heading direction and the *x*-axis. The reference inputs for these two control loops are obtained by first applying the artificial potential field method used in obstacle avoidance [14] for generating the reference trajectory of the robot. Then, there are performed simple computations that employ the tracking errors for the *x*- and *y*- axes and the maximum accepted values for these errors.

The paper is organized as follows. In the following section the concept of the Intelligent Space (IS) will be introduced and the dynamic model used in the tracking control problem for mobile robots together with the CS structure, and a formal description of the artificial potential field method is given. Section III presents the development method for the PI-FCs as special 2-DOF controllers. Section IV provides simulation results to validate the method. Since in the case of mobile robot control there can appear often parametric variations of the controlled plant, it is necessary to perform the sensitivity analysis with this respect, and Section V offers sensitivity models. Section VI is focused on the conclusions.

II. INTELLIGENT SPACE. DYNAMIC MODEL OF MOBILE ROBOTS. TRACKING CONTROL SYSTEM STRUCTURE

The IS represents a space (room, corridor or street), which has distributed sensory intelligence (various sensors, such as cameras and microphones with intelligence, haptic devices to manipulate in the space) and it is equipped with actuators [15]. Actuators (speakers, screens, pointing devices, switches or robots and slave devices inside the space) are mainly used to provide information and physical support to the inhabitants. The various devices of sensory intelligence cooperate with each other autonomously, and the whole space has high intelligence [16], [17]. Each intelligent agent in the IS has sensory intelligence [18]. The intelligent agent has to operate even if the outside environment changes, so it needs to switch its roles autonomously. The agent knows its role and can support man. The IS recomposes the whole space from each agent

Process Based Associative Configuration of Robot System with Extended Sets of Features

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***Abstract* - Integrated modeling of robot process is analyzed and a new approach is proposed in this paper. Similarly to other integration efforts in modeling of products and production, associativity definition based integration of assembly and robot assembly process feature models is proposed. Full feature driven shape modeling ensures definition of model entities for objects defined by product design and robot manufacturing engineers. The ultimate aim is an alternative modeling technology to the conventional geometry based programming of robots. The present prevailing boundary represented form feature definition of part shape in models is integrated with robot assembly process model features. Relationship based integration of part models in assembly model is extended to robot assembly configuration relationships. Robot assembly process features are related to relationship features. This paper introduces an integrated product model based approach to robot process modeling and programming. An integrated modeling is outlined for robot applications, where shape aspects defined for parts are configured and related to achieve the required model. Following this, modeling of part placing in an unified representation environment of form features is explained. Finally, the solution for integration of model of task oriented robot process by the authors is introduced and discussed.**

I. INTRODUCTION

The conventional control of robots can not utilize engineering related information described by advanced application oriented product models. Instead, elementary geometric information is necessary for the definition of trajectories. On the other hand, engineering related definition of the shapes involved in the robot process can not be used directly for the purpose of geometric oriented path planning of robots. The only way is application of engineering related model description to produce geometric information for path planning. The main content of the related research of the authors is integration of the related shape and robot process model descriptions in order to achieve geometric information for path planning and, at the same time, to make decisions on the level of engineering related model entity definitions.

Related works deal mainly with issues in separated important problem complexes of description of shapes and trajectories in robot work space, strategies of assembly, disassembly and assembly path planning. In [1], a comprehensive environment is discussed for definition of assembly. Solid models are used at feature recognition. In [2], an approach is applied to generate a graph of collision free paths, in which the nodes are the milestones and the edges the simple paths.

The authors analyzed the conventional computer aided manufacturing methods applied in control of assembly robots. They proposed form feature based shape modeling method to replace geometry-based definition of robot trajectories in [3]. They also proposed a four leveled robot process model and adapted it to specific applications in robot assembly [4]. During other earlier works, the authors defined application-oriented groups of form features for integrated robot systems in [5], [6].

Form feature driven modeling of the robot system is based on robot assembly process oriented shape aspect definitions. A shape aspect, called as form feature, is application oriented building element of shape. The application in this case is modeling of parts both for the product to be assembled and the robot applied for the assembly. This paper focuses on relating models in the whole robot assembly system including product and robot assemblies.

The proposed modeling covers a possible solution for the problem of advanced product model driven control of industrial assembly robots. Comprehensive solution of this problem have not offered by the numerous excellent researches in related topics as robot navigation, adaptive tracking, autonomous features of robots and behavior of robots. New problems are emerged and solved by application of connected robot arms [7]. Behavior based modeling, especially in the case of motion coordination, can be realized by using of the control approach discussed in [8]. Complex navigation and obstacle avoidance models can be realized by using of neural networks as in [9]. Finally, product models can be completed by model application purposed knowledge in the form of associativity definitions. These models offer the possibility of integration with results of researches as the above mentioned ones.

This paper introduces an integrated model based approach to robot process modeling and programming. An integrated modeling is outlined for robot applications, where shape aspects defined for parts are configured and related to achieve the required model. Following this, modeling of part placing in an unified representation environment of form features is explained. Finally the solution for integration of model of task oriented robot process by the authors is introduced and discussed.

Robot Programming Based on Ubiquitous Sensory Intelligence

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ABSTRACT

Intelligent Space based on ubiquitous computing is a space which has distributed sensory intelligence and is equipped with actuators. The various devices of ubiquitous sensory intelligence cooperate with each other autonomously, and the whole space has high intelligence, where we can easily interact with computers and robots, and get useful services from them. This document proposes a system which is using Intelligent Space to help the process of the Intuitive Robot Programming. In IRP the desired motion of the robot is performed by a skilled worker. The motion is recorded by some motion capture equipment. Finally the captured motion path can be edited and simulated by a software, and the result can be programmed into a robot.

I. INTRODUCTION

A. Intelligent Space

Intelligent space is a limited space (room or building, street or area, or even a whole country), which has ubiquitous computing type computing and sensory intelligence. The sensors might be various types of equipment, such as cameras, microphones, haptic devices, weight sensors, or any other devices that collect information on the state of the space. A conceptual figure of the Intelligent Space is shown in Fig. 1. [6]

The various devices of ubiquitous sensory intelligence cooperate with each other autonomously and the whole space has ubiquitous computing background. This is true even if there is a supervision system involved, which is acting as an autonomous agent itself. Each agent in the space has sensory intelligence. (Or has intelligent inputs coming from other agents.) An intelligent agent has to operate even if the outside environment changes, so it needs to switch its roles autonomously and knowing its role it can still help and support humans within the space. I-space having ubiquitous computing recomposes the whole space from each agents sensory information and returns intuitive and intelligible reactions to human beings. In this way, i-space is the space where human beings and intelligent ubiquitous computing agents can interact mutually.[5] [8]

B. Intuitive Robot Programming

Intuitive Robot Programming (IRP) is a new concept. This concept significantly reduces the programming time of industrial robots. The IRP system consists of:

- coordinate tracking device
- software package
- industrial robot

The coordinate tracking device captures the motions of a skilled operator that accomplishes the desired task, the software package which processes the data into a standard robot program to be uploaded directly to the robot controller. The software package also contains 3D visualization, editing functions and application packages. IRP will contain interfaces to

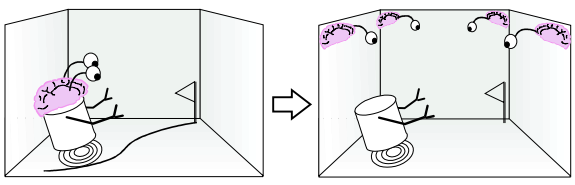

Fig. 1
CONVENTIONAL CONCEPT → INTELLIGENT SPACE CONCEPT

The Helping Hand in Humanoid Robot Learning

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***Abstract*— Human caregivers play an important role during child's development phases. A human tutor often modifies a task context so that information is easily perceived and learned by the child. We propose to use the same strategy to teach a humanoid robot. Contrary to standard supervised learning techniques relying on a-priori availability of training data obtained manually, actions by an embodied agent (the human) are used to automatically generate training data for the learning mechanisms, so that the robot develops categorization autonomously.**

The work presented in this paper follows a developmental approach to perception and learning. This framework based on human-robot interactive communication is demonstrated to apply naturally to a large spectrum of computer vision problems: object segmentation, visual and cross-modal object recognition, object depth extraction and localization from monocular contextual cues, and learning from visual aids – such as books.

I. Introduction

Embodied and situated perception [3] consists of boosting the vision capabilities of an artificial creature by fully exploiting the opportunities created by an embodied agent situated in the world [2]. Proponents for Active vision [1], [8], contrary to passive vision, argue for the active control of the visual perception mechanism so that perception is facilitated. Percepts can indeed be acquired in a purposive way by the active control of a camera [1]. This approach has been successfully applied to several computer vision problems, such as stereo vision - by dynamically changing the baseline distance between the cameras or by active focus selection [14].

We argue for solving a visual problem by not only actively controlling the perceptual mechanism, but also and foremost actively changing the environment through experimental manipulation [3], [12]. The human body plays an essential role in such a framework, being applied not only to facilitate perception, but also to change the world context so that it is easily understood by the robotic creature (the humanoid robot Cog used throughout this work is shown in Figure 1).

Although a human can help the robot to extract meaningful percepts from the world, it should be emphasized that such help should not include constraining the world structure in anyway, such as the removal of environment clutering or careful luminosity setup, among others, since both children and robots exist in real, not virtual, worlds. Instead, the focus should be placed on communicating information to the robot which boosts its perceptual skills, helping *him* to filter out irrelevant information. Indeed, while teaching a toddler, parents do not remove the room's furniture or buy extra lights to just show the child a book. Help instead is given by facilitating the child's task of stimulus selection (for example, by pointing or tapping into a book's image).

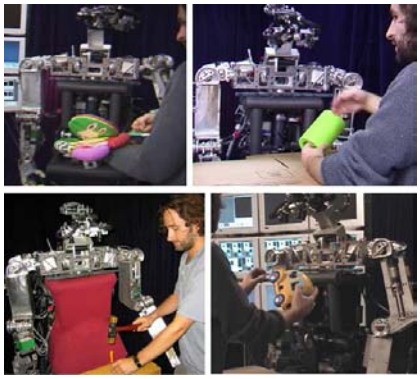

Fig. 1. The experimental platform. The humanoid robot Cog is equipped with cameras in an active vision head, a microphone array across the torso and two robotic arms. Some typical learning scenarios (from left to right, top to bottom) a human shows a book to Cog; a human describes the shape of an object to the robot; a repetitive action (hammering) is demonstrated to the robot; a human waves a yellow car to create a salient stimulis on Cog's attentional system.

This paper presents a human-centered approach to facilitate the robot's perception and learning, while showing the benefits that result from introducing humans in the robot's learning loop. This work aims at teaching humanoid robots as children, being the child's mother role attributed to a human tutor. With that in mind, next section will present software tools developed to enable human-robot interactions during important learning activities for children: playing with toys, tools, books and drawings. An approach for learning the structure of the robot's surrounding world is presented in Section III. Such structure is inferred from cues introduced by humans. Finally, conclusions are drawn in Section IV, together with a discussion on ongoing work.

II. Human-Robot Playing Activities

A. Books

During developmental phases, children's learning is often aided by the use of audiovisuals and especially, books. Humans often paint, draw or just read books to children during the early months of childhood. Books are indeed a very useful tool to teach robots different object representations or to communicate properties of unknown objects to them (such as a whale's visual appearance). We present a human aided object segmentation algorithm [7] to extract

High Accuracy Stereovision Approach for Obstacle Detection on Non-Planar Roads

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***Abstract*–This paper will present an obstacle detection system that that relies on the 3D information provided by stereo reconstruction. The 3D features must be separated in road features and obstacle features. Instead of relying on the flatness of the road, the vertical road profile is modeled as a clothoid, and is estimated from the lateral projection of the 3D points. The points above the road are selected for grouping into objects, based on vicinity criteria and the variation of the point density with the distance. The resulted objects are used as measurements for a model-based tracking algorithm. The resulted system is a high-accuracy, far distance obstacle detector, able to function in a large variety of real-world scenarios.**

I. INTRODUCTION

Detecting the surrounding environment of a moving vehicle is a complex and challenging task. One of the most important components of the environment is the set of obstacles, which can be other vehicles, stationary side objects, pedestrians, etc. Detection of the obstacles implies, directly or indirectly, the use of some kind of 3D information, and this is the reason why the active sensors, such as laser or radar, are the prime choice of industry. However, the use of a high resolution, high accuracy stereovision algorithm provides comparable results in 3D estimation, while delivering a larger amount of data, thus making the grouping and tracking tasks easier, and allowing a subsequent classification of the obstacle.

Obstacle detection through image processing has followed two main trends: single-camera based detection and two (or more) camera based detection (stereovision based detection). The monocular approach uses techniques such as object model fitting [1], color or texture segmentation [2,3], symmetry axes [4] etc. The estimation of 3D characteristics is done after the detection stage, and it is usually performed through a combination of knowledge about the objects (such as size), assumptions about the characteristics of the road (such as flat road assumption) and knowledge about the camera parameters available through calibration.

The stereovision-based approaches have the advantage of directly measuring the 3D coordinates of an image feature, this feature being anything from a point to a complex structure. The main constraints concerning stereovision applications are to minimize the calibration and stereo-matching errors in order to increase the measurements accuracy and to reduce the complexity of stereo-correlation process. The real time capability of the method is another important constraint. Such a method was proposed in [5]. The full 3D reconstruction of the visible scene is performed only on vertical or oblique edges. The list of obtained 3D points is grouped into objects based solely on density and vicinity criteria. The flat road assumption for the ground/obstacle points separation process was used. The system detects obstacles of all types, outputting them as a list of cuboids having 3D positions and sizes. The detected objects are then tracked using a multiple object-tracking algorithm, which refines the grouping and positioning, and detects the speed and orientation.

An important part in the obstacle detection process is the separation of the obstacle points from the road points. Most of the roadway obstacle detection methods are based on the flat road assumption [6,7]. This is a poor model since deviations from the flat road may be as large as or larger than the obstacles we wish to detect. In consequence the road objects separation and the 3D objects position estimation cannot be done. Therefore the non-flat road assumption is compulsory for a robust object detection method. In literature this assumption was introduced by non-flat road approximation by series of planar surface sections [8,9] or by modelling of the non-flat roads by higher order surfaces [10,11]. For instance the methods presented in [11,12,13] are fitting the parameters of a 3D clothoid model of the road lane using a monocular image and supplementary lane geometry constraints.

Our approach presented in this paper will model the vertical profile of the road surface with such a clothoid curve fitted directly on the detected 3D road surface points. These 3D road points are detected using a high accuracy stereovision method [5]. The obtained vertical profile will be used for the road-obstacle separation process in order to have a proper grouping of the 3D points in obstacles and precise estimation of their 3D position in the driving environment.

II. CALIBRATION OF THE STEREO SYSTEM

In order to reconstruct and measure the 3D environment using stereo cameras, the cameras must be calibrated. The calibration process estimates the camera's intrinsic parameters (which are related to its internal optical and geometrical characteristics) and extrinsic ones (which are related to the 3D position and orientation of the camera relative to a global world coordinate system).

The intrinsic parameters of each camera are calibrated individually. The estimated parameters are the focal length and the principal point coordinates and the lens distortions. The parameters are estimated by minimizing the projection error from multiple views of a set of control points placed on a coplanar calibration object with known geometry. For a stereo system of two cameras, the obtained intrinsic

A framework of reusable structures for mobile agent development

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Abstract – **Mobile agents research is clearly aiming towards imposing agent based development as the next generation of tools for writing software. This paper comes with its own contribution to this global goal by introducing a novel unifying framework meant to bring simplicity and interoperability to and among agent platforms as we know them today. In addition to this, we also introduce a set of agent behaviors which, although tailored for and from the area of virtual learning environments, are none the less generic enough to be used for rapid, simple, useful and reliable agent deployment. The paper also presents an illustrative case study brought forward to prove the feasibility of our design.**

Keywords: mobile agents, agent behavior, unifying agent platform framework

I. INTRODUCTION

Although agent platforms are becoming increasingly widespread and powerful these days, although they are evolving rapidly towards what some call a "second generation" and although they are the centerfold of extensive research all around the world, there still appears to be something which prevents them from being universally adopted as a natural evolution of the object oriented world. In our opinion, there are actually two things, not just one, which can be held responsible for the current situation: lack of simplicity and lack of interoperability.

Let us discuss lack of simplicity first. Most agent platforms nowadays find themselves in one of the two extremes: they either offer enormous flexibility at the cost of usability (the user gets tangled in aspects that are completely irrelevant to her application, thus losing perspective) or they offer extended built-in functionality at the price of interoperability and extensibility (the user has plenty of predefined agent services to choose from and plug into her application, but is confined to the specific agent platform). The JADE [7] and the ADK [8] agent platforms both fall into one of the two above categories. Neither of these extremes can completely satisfy the user's requirements. Ideally, an agent platform should offer the means for the user to easily set up and run her agents (if so required) and also the flexibility of changing virtually everything about an agent if the need arises.

We also mentioned lack of interoperability in the argument above. This is a bit more difficult to see, especially for the untrained eye, due to the standardization efforts such as those of FIPA [6] which allow a certain degree of interoperability between agents built on top of different agent platforms, or due to included semantic support, such as that provided by ontologies. The catch, however, is that compatibility among agents belonging to different frameworks which are FIPA-compliant is virtually restricted to what FIPA defines. This is a serious drawback, if one cares to analyze it, because FIPA defines nothing in terms of components which can be used for rapid agent development and deployment. The implication of this fact is that implementation efforts employed by various agent platform developers are not reusable outside their own platform (at least not without serious adaptations efforts). The ultimate goal should be for the user to be able to simultaneously benefit not only from a single, but from all development work conducted by researchers and implementors all around the globe.

These are the two main deficiencies which we have tried to address with our work. Our idea was to overcome such limitations by defining an abstract, platform independent, framework which would allow the user to easily:

- define her agents in terms of high level abstractions;
- be able to "plug in" various common predefined behaviors;
- switch from one platform to another as the need arises.

Given that the area where we make use of agents falls roughly into the category of computer based education, the idea described before was primarily focused on the development of a framework which would allow us to benefit from all the aforementioned improvements in our line of work. As a consequence, we narrowed our agent directed research down to field of virtual learning environments (VLE). This does not mean, however, that we didn't design our framework to be as general as possible. It merely implies the fact that the behaviors we have identified and introduced into our implementation were drawn mainly from the VLE field. Even so, by reading the paper, it will become obvious that most of behaviors described are equally applicable to a variety of other fields as well.

In short, a virtual learning environment represents a space available on-line where both students and teachers are brought together to interact similarly to the way they do in reality. There are a few things pertaining to a VLE which allowed us to make certain simplifying assumptions in our work. In the first place, a VLE is usually what one calls a "closed environment", meaning it has few (if any) interactions with other systems. This has a direct consequence in that our agents will usually be confined to using "interior" (as opposed to "border") protocols only. Secondly, strong security requirements are normally absent from a VLE, which makes concerns for agent

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OPTCHOICE - Web Enabled Optimal Choice

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***Abstract – OPTCHOICE* is a package consisting in: a software capable to define and solve in remote regime, using the Internet, optimal choice problems, a technology to enclose, in e-business applications, the ready-made modules for optimal choice of a decisional alternative, and finally, a library containing technology's applying samples. The optimal choice is based on a multiple attribute decision-making model. The model is general, with more than one decision-makers and states of nature, the attributes being of cardinal, ordinal, Boolean and fuzzy type. It benefits from knowledge-based computing for inconsistency avoiding. Regarding the problem solving, there are five generalised solving methods and one rule-based procedure to get a unique optimum. In order to prove the efficiency in using this technology, the paper focuses on the samples built.**

I. INTRODUCTION

Advanced e-applications have a large set of characteristics that individualize very well this class of *e-applications* [1]. The most important discriminating characteristic is the embedding of the mathematical modeling and artificial intelligence. This paper will present thee practical results in using a technology for developing advanced e-applications that use optimal choice over a set of decisional alternatives, namely: *Tele-SUPPLY*, *Tele-AUCTION* and *Tele-PROCESSING*. Moreover, at the beginning of the paper, the *OPTCHOICE* software and the *OPTCHOICE* technology will be lightly sketched because these components are stilling under final testing and improvements.

II. *OPTCHOICE* SOFTWARE

The *OPTCHOICE* software will be the product capable to define and solve in remote regime, using the Internet, optimal choice problems. It will be the promoter of the package with the same name because it will be free to access it from every corner of the world. So, this service will educate a large category of *e-applications* developers to increase the quality of their production by using mathematical modeling and artificial intelligence. The power of this product will be revealed by shortly presenting its "engine".

A. Decisional Mathematical Model

The decisional process is a multitude of human activities consisting mainly in the realization of the existence of more than one possible course of action in a certain given context, the analysis of their consequences with respect to the envisaged goal, the choice and implementation of the action that is considered optimal in the axiological perspective that has been adopted.

In this section will be briefly presented the Multi-Attribute Decision Making (MADM) mathematical model and the Optimal Choice Problems (OPCs) generated over this. The OCP can be easy handled in the MADM theory. The MADM framework involves the following elements: a set of decision-makers (whose elements are the persons with assignments in the process of defining and solving the OCP), a set of states of nature (each one of them synthetically signifying the totality of circumstances that determines for a specific OCP variations in its formulation), a set of objects (containing the decision alternatives), a set of attributes (consisting in those characteristics which are evaluated for every decision alternative). An attribute may be expressed in a Boolean, cardinal, ordinal or fuzzy manner (by triangular membership functions), but this expression must be unique for a fixed attribute. Each attribute has an associated variation interval (according to its type) and an associated interval of standard values. Also ones consider an indicator which may take two values, "max" or "min", depending on the fact that the attribute the greater it is the better is considered or the smaller it is the better is considered respectively. Considering the above four sets as support, two functions are constructed. First, the absolute importance of each decision-maker / state of nature / attribute, considered in the multitude of decision-makers / states of nature / attributes. The absolute importance has the property that summed upon all existing elements gives one. Second, the evaluation of all attributes for every object, in every state of nature and in the opinion of every decision-maker. This function is usually known as characteristics matrix. It has a hybrid character, being divided, intuitively speaking, into two areas: the first is the "well-defined area" of the matrix, in which every attribute has a well-defined value for every object, for every state of nature and in the opinion of every decision-maker; the second is the "ill-defined area", meaning that the values of certain attributes in relation to certain objects in certain states of nature are unknown or that they cannot be expressed by some of the decision-makers, possibly, by most of them. Ones can speak of a well-defined area and an ill-defined area because it is up to the human factor to give the matrix elements. Taking the above structured information as factual base, a productions set *P* (expressed in the general format) for unstructured information modeling, is also considered.

The alternative goals of OCP are:

1) To determine an optimal object, without providing reporting information to other objects;
2) To achieve an objects hierarchy;
3) To evaluate each object in von Neumann - Morgenstern sense. From a practical point of view, these goals are equivalent but the quality of global information increases from the first goal to the third goal.

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Distributed database system in interaction with XML, an identification problem

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***Abstract* – In last years XML has been accepted as the new standard for data representation and exchange on the Internet (EDI). This paper takes in discussion the situation where two or more enterprises, like a bank and a business, have common customers and there are frequent transactions between (by example direct debit). Each of them is supposed to have it's own customer database (distributed). The databases in general are heterogeneous but have the capabilities to treat XML documents (input and output). The identification problem appears when the same real-life object has different identifiers in different databases. We propose the usage of synonyms for candidate attributes of identifiers and focus on XML capabilities to express multivalued values for an attribute element. The system has the ability to maintain such relation between synonyms and primary keys. It has the capacity to learn new rules from facts also stored in XML document which is the means of exchange.**

I. INTRODUCTION

A. An example helping us in describing the identification problem

In last years Electronic Data Interchange (EDI) had found new opportunities.

Data integration [11] is made sharing resources or by sending data using networking and inter-process communication mechanisms. Example of first is today's Enterprise Resource Planning (ERP) packages e.g. the customer service application understands the schema and relationships for its own tables as well as the tables for sales and financial information.

Integration through data exchange creates a loosely coupled relationship between applications. This approach implies significant custom code to perform mappings between the two loosely coupled schemas.

For simplify the presentation, we take two generic enterprises named "Businesses" (B1 and B2 in fig. 1). Each of them has its own applications and database. There is no presumption as regards database schema. The two businesses have to cooperate in administer to their (common) customers.

An example is with a bank and a regular services company. A company customer instructs his bank to collect varying amounts from his account, as long as the customer has been given advance notice of the collection amounts and dates (direct debit).

The most common model for DB (DataBase) is the relational model. An enterprise may have a hierarchical organization and DB should be distributed over many sites. The rule thereupon values for keys are assigned in organization's DB is pure subjective. Suppose a new client which makes a demand. This client must be recorded in *Customer* table where the object will get an *idcust*. The problem is to discern if a client is really a new client or it is an old. Here, existence of candidate key such as personal identification number or a combination of forename, surname and other characteristic that guarantee uniqueness (like initial letter of parent's forename) is very important.

In such a situation where the database is distributed the system has to search every location (that means overload of communication) to assure uniqueness of the identifier. In a system with active database capabilities it is more convenient to state some rules that will govern trigger's logic as in [6]. A rule could be: "Customers are allocated according to location of their address". This rule implies that there exists *Address* relation and it is fragmented over locations. Each location has a correspondence table with all address localities allocated to that location. At this rate trigger's choice between fragments of *Customer* table will be straightforward.

There are many possibilities to implement such a distributed database. One way is with pure distribution where each node in the system is a fragment and where global schema is obtained at the external level (by example partitioned views). Replication is another solution [5], but the two could be combined.

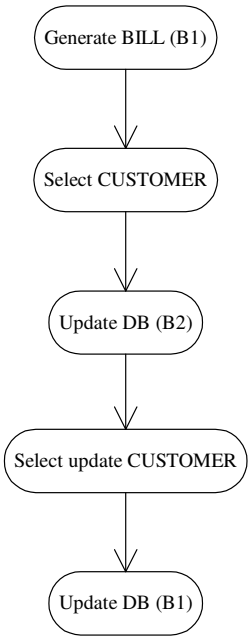

Fig. 1. Activity diagram for the example taken into discussion[1]

[1] The stages deal with collection of customers although singular was used for nouns.

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Database Security Models – A Case Study

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Abstract – **Since information stored in databases is usually considered as a valuable and important corporate resource, security is a major issue in any database management system, particularly those that use sensitive information. Database security cannot be seen as an isolated problem because it is affected by other components of a computerized system as well, like the operating system. Therefore many of the security models developed for trusted OSs can be adapted to DBMSs. Security models are the basic theoretical tool to start with when developing a security system. This still seems to be an issue which is insufficiently understood and it may be an explanation for the actual "security crisis" of information systems. Most corporations try to address their security problems by simply "patching" their existing systems to eliminate identified vulnerabilities. In most cases this is already too late and on the long term such a strategy (or lack of strategy) is a sure looser. In this paper we advocate for the use of security models as an approach to systematically address the security issue starting from the early stages of the system design.**

I. INTRODUCTION

Since information stored in databases is usually considered as a valuable and important corporate resource, security is a major issue in any database management system, particularly those that use sensitive information. A database contains data of various degrees of importance and it is shared among a wide variety of users, so it needs to be protected and managed because any change to the database can affect it and affect other related databases.[1][9] Database security cannot be seen as an isolated problem because it is affected by other components of a computerized system as well, like the operating system. Therefore many of the security models developed for trusted OSs can be adapted to DBMSs. However there are several differences between OSs and DBMSs, from a security perspective like, **object granularity** (OSs typically act at file level, DBMSs at various lower levels), OSs deal with physical objects, DBMSs deal with logical objects, presence of semantic correlations among data in databases, DBMSs store and manage metadata etc. [10][11] Security models are the basic theoretical tool to start with when developing a security system. This still seems to be an issue which is insufficiently understood and it may be an explanation for the actual "security crisis" of information systems. Most corporations try to address their security problems by simply "patching" their existing systems to eliminate identified vulnerabilities. In most cases this is already too late and on the long term such a strategy (or lack of strategy) is a sure looser. In this paper we advocate for the use of security models as an approach to systematically address the security issue starting from the early stages of the system design. We briefly review the main security models proposed for database and operating systems, and conclude by a case study of how the Clark Wilson model maps to the Windows NT security system.

II. SECURITY MODELS

The role of any security system is to preserve *integrity of an operational system* by enforcing a *security policy* defined by a *security model*. System integrity refers both to data integrity, i.e. data is correct and accurate, and system integrity that is the system is in operation and works correctly. System integrity is achieved by rigorous control and management of subjects (users, processes) to objects (data, programs). This control is governed by a set of rules and objectives called a ***security policy***. *Security policies* are governing principles adopted by organizations. They capture the security requirements of an organization specify what security properties the system must provide and describe steps an organization must take to achieve security. *Security models* are formal descriptions of security policies. Security models are useful tools for evaluating and comparing security policies. Security models allow us to test security policies for completeness and consistency. They describe what mechanisms are necessary to implement a security policy.[1]
Security models are described in terms of the following elements:

- **Subjects -** entities that request access to objects.
- **Objects -** entities whose accesses are controlled by the security system.
- **Access modes –** type of operation performed by subject on object (read, write, create, etc.)
- **Policies –** enterprise wide accepted security rules.
- **Authorizations –** specification of access modes for each subject on each object.
- **Administrative rights –** who has rights in system administration and what responsibilities administrators have.
- **Axioms –** basic working assumptions.

III. CLASIFICATION OF DATABASE SECURITY MODELS

Because of the diversity of the application domains for databases different security models and techniques have been proposed to counter the various threats against the security:

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On Investigating the Security and Fairness of a Fair Exchange Protocol using logic-based verification

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Abstract – **Traditionally, informal and intuitive techniques have been used in the design and verification of cryptographic protocols. However, informal verification alone can lead to subtle protocol flaws and weaknesses remaining unidentified. Conversely, formal verification techniques provide a systematic approach to discovering protocol flaws and weaknesses. This paper presents an investigation into the security and fairness of a fair exchange protocol using logic-based verification. The paper introduces properties of non-repudiation protocols. A logic-based analysis technique, suitable for verifying these protocols is outlined. The verification process is demonstrated by way of a case study on a fair non-repudiation protocol to determine if the protocol is secure.**

I. INTRODUCTION

Cryptographic protocols are designed to provide security services, such as key distribution, authentication and non-repudiation, over insecure networks. These protocols are an indispensable component in providing services for applications on mobile and fixed networks such as: certified e-mail, secure e-business, and inter-bank transactions.

The design process of cryptographic protocols is particularly complex and error-prone. The surprisingly significant number of published protocols that have subsequently been found to contain various flaws [1],[2], [3], sometimes several years after the original publication, highlights the complexity of the design process. The absence of formal verification of these protocols can lead to flaws and security errors remaining undetected.

Formal methods provide means to verify such protocols thoroughly, adding confidence in the correctness of a protocol to a level unrivalled by informal methods. The use of logics has been shown to be effective in detecting flaws in the design of numerous protocols [4],[5],[6],[7], [8].

Non-repudiation services enable accountable and undeniable data exchange between two or more principals [9]. This involves the generation of non-repudiation information to prove that the originator sent the data and that the recipient received the data. In [10],[11],[12], security protocols were proposed to provide non-repudiation services for data exchange using computer networks as a communication medium.

This paper introduces properties of non-repudiation protocols. Logic-based analysis techniques, suitable for verifying these protocols are outlined. The verification process is demonstrated by way of a case study on a fair non-repudiation protocol [11].

A modal logic [7], which combines the logics of knowledge and belief, is used as part of the verification process. The formal verification of the protocol is presented and the results are discussed. The results indicate a weakness in the protocol, highlighting the importance of formal verification as part of the security protocol design process.

II. LOGIC-BASED ANALYSIS OF PROTOCOLS

Logic-based formal verification has been shown to be effective in detecting design flaws in security protocols that can lead to serious protocol failure [3]. The process of logic-based verification can be summarized in the following steps:

1. Formalisation of the protocol messages;
2. Specification of the initial assumptions;
3. Specification of the protocol goals;
4. Application of the logical postulates.

The first step involves specifying the protocol under investigation in the language of the logic by expressing each protocol message as a logical formula. This step is known as protocol formalisation or idealisation. A formal description of the protocol, obtained by formalisation, attempts to show the purpose components of each message so as to avoid any ambiguity.

In step two the initial protocol assumptions, which reflects the beliefs and possessions of the involved principals at the beginning of each protocol run, are specified.

The desired protocol goals are then expressed in the language of the logic. These goals are specified in terms of the beliefs and possessions of the protocol participants at the end of a successful protocol run.

Step four of the verification concerns the application of logical postulates to establish the beliefs and possessions of protocol principals. The objective of the logical analysis is to verify whether the desired goals of the protocol can be derived from the initial assumptions and protocol steps. If such a derivation exists, the protocol is successfully verified (within the scope of the logic); otherwise, the verification fails.

III. REASONING ON PROPERTIES OF NON-REPUDIATION PROTOCOLS

Non-repudiation protocols are generally analysed in terms of *non-repudiation*, *timeliness* and *fairness*.

Non-repudiation allows an exchange of data between two principals in such a manner that the principals cannot subsequently deny their participation in the exchange [13].

Timeliness states the protocol should terminate in a finite amount of time, thus avoiding any of the involved entities to wait an indefinite amount of time in order to

DTNLite: A Reliable Data Transfer Architecture for Sensor Networks

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***Abstract*— We present a network architecture, *DTNLite*, for reliable message delivery in sensor networks facing problems of high mobility, frequent disconnections and unreliable nodes . It is based on the DTN(Delay Tolerant Networking) architecture and its main features are asynchronous message delivery combined with custody transfer on an overlay network of sensor motes. We present an implementation of this architecture for the TinyOS platform targeting data collection applications. We also explore the various issues in reliable custody transfer and investigate the particular issue of *querying and selection of custody hops* in detail. Our simulation results show that selection criteria that use energy or delay as metrics are able to profitably exploit asymmetries in the network.**

I. Introduction and Motivation

Wireless sensor networks are a cost effective, distributed solution, providing sensing and computing solutions in various environments where conventional networks are impractical. This paper addresses the design of system support for reliable data delivery in sensor networks facing challenges such as sparse connectivity, high degree of mobility, flaky nodes and unreliable links. However the key questions are why reliability, why challenged sensor-nets, and why reliability in challenged sensor-nets?

Unlike traditional networks, reliability in sensor networks is still an open research question. There has been little amount of work on the design of reliable delivery protocols, and most of the existing solutions are application-specific. However, as sensor networks become ubiquitously deployed, we can imagine a large class of applications where reliable delivery is required. A good example is network reprogramming of sensor nodes, where the reliable delivery of every single byte of code is necessary. Reliable and timely delivery of emergency events is another.

The majority of current solutions for sensor nets assume high connectivity degrees, manageable mobility and low error rates. However, few real environments can have such well-controlled parameters, and providing these properties requires large numbers of nodes, and important energy consumption. Covering extended sensing areas is achievable by tolerating smaller node density, and maintaining a long lifetime recommends small on-times. All these are reasons for exploring solutions for challenged networks.

II. Related Work

In this section we provide a brief survey or related work in the areas of reliable data delivery in sensor and delay tolerant networking.

Efficient transport protocols to provide reliable data delivery in sensor networks have been proposed in [9] and [8].

In [8], authors introduce *RMST*, a transport protocol that provides guaranteed delivery and fragmentation/reassembly for applications that require them. *RMST* is a selective NACK-based protocol that can be configured for in-network caching and repair. Some number perform message reassembly, issuing repair request to the previous nodes in the path.

In [9], the *Pump Slow Fetch Quickly* protocol is presented, where each node performs a special type of message reassembly. That is, nodes can immediately forward to the next hop fragments if they are received in order. However, as soon as they receive an out-of-order fragment, they issue a repair request, and buffer the out-of-order fragment until the missing fragment is obtained and relayed. Nodes are thus performing fragment ordering. The repair requests are answered by previous nodes in the path that use fragment caches. PSFQ targets a small delay, comparable to forwarding approaches, combined to the reliability and small number of retransmissions specific to hop-to-hop store-and-forward.

Delay Tolerant Networking is an emerging field that attempts to develop a networking architecture[2] and philosophy revolving around asynchronous message delivery with custody transfer for networks that are subject to long delays and/or frequent disconnections that rule out contemporaneous end-to-end connections. The architecture operates as an overlay above the transport layers of the networks it interconnects, and provides key services such as in-network data storage and retransmission, inter-operable naming, authenticated forwarding and a coarse-grained class of services. Some of the issues involved in the custody transfer handshake and duplicate generation are discussed in [3].

III. Design Decisions

In this work, we explore achieving reliable delivery using acknowledgments and retransmissions. The best possible solution is the one that makes the most efficient use of retransmissions and storage(in volatile and non-volatile memory). The end-to-end argument dictates end-to-end acknowledgment as the only true answers for reliability. However, adding functionality at the intermediary hops can significantly increase efficiency.

Packets can be retransmitted at each hop, at some number of intermediate hops, or only at the source. Each

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A framework for QoS-enabled middleware

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Abstract - **Developers of distributed multimedia applications face a diversity of multimedia formats, streaming platforms and streaming protocols; furthermore, support for end-to-end Quality-of-Service (QoS) is a crucial factor for the development of future *distributed multimedia and real time systems.* Middleware is gaining wide acceptance as a generic software infrastructure for distributed applications, a growing number of applications are designed and implemented as a set of collaborating objects using object middleware, such as CORBA, EJB and (D)COM(+), as a software infrastructure that facilitates distribution transparent interactions. However, quality aspects of interactions between objects cannot be specified nor enforced by current object middleware, resulting only in a *best-effort QoS* support in middleware. Next generation object middleware should offer abstractions for management and control of the system level QoS mechanisms, while maintaining the advantages of the distribution transparencies, these abstractions should take into account that new interfaces to OS resources and new network protocols are expected to appear as the result of ongoing research efforts, in addition, a changing run-time environment must be handled. The paper discusses the design and implementation of a QoS-enabled middleware platform with QoS guarantees. Properties of content delivered are represented using a generic content representation model described using the OMG Meta Object Facility (MOF) model. The integration of the QoS support, content representation and content delivery framework results in a *QoS-enabled middleware* which is representation, location and QoS transparent. This paper presents aspects of the framework for controlling QoS at middleware level implemented as a provisioning QoS service, supporting this new paradigm of QoS-enabled middleware .**

I. INTRODUCTION

Middleware provides distributed objects with a software infrastructure that offers a set of well-known distribution transparencies. These transparencies enable the rapid introduction of applications for heterogeneous, distributed systems. However, to support guaranteed Quality of Service (QoS) system-specific QoS mechanisms need to be controlled. Allowing applications to directly access and control these mechanisms would negatively impact the distribution transparencies offered by the middleware layer and would reduce the portability and interoperability of distributed object applications. To avoid this, *next generation object middleware should offer abstractions for management and control of the system level QoS mechanisms*, while maintaining the advantages of the distribution transparencies. The challenge for next-generation middleware is to support application-level QoS requirements, coherent mapping on low level mechanisms, while maintaining the advantages of the distribution transparencies.

This paper is organized as follows. Section 2 describes the QoS concept in open distributed systems. Section 3 gives an overview of the requirements for a middleware-based software infrastructure that offers QoS support to distributed objects and a survey of existing frameworks Section 4 presents our solution in the form of an infrastructure service for QoS provisioning. With a short evaluation of this framework based on the implementation section 5 completes with conclusions and further developments.

II. A CONCEPTUAL FRAMEWORK

Provisioning of QoS usually involves a common understanding between the two or more parties about the quality characteristics of the service, these parties can be end-users or software components. The generic concepts are based on the ISO/IEC QoS Framework, and the provisioning model defines as main entities in the system the service provider and the service user. Often the user requirements are expressed as subjective requirements whereas the service provider needs objective requirements in order to handle them, therefore the user requirements must be translated into specific QoS parameters expressed in terms of QoS characteristics of the Service provider. The QoS provisioning model should enable entities to express their quality requirements. The relevant concepts for a QoS provisioning model [2] are defined as follows:

- *QoS characteristic:* a quantifiable aspect of QoS, which is defined independently of the means by which it is represented or controlled.
- *QoS requirement:* QoS information that express part or all of a requirement to manage one or more QoS characteristics, when conveyed between service user and provider a QoS requirement is expressed in terms of QoS parameters.

The QoS characteristics of the service provider are determined by the QoS management functions

- *QoS management function* define a functions specifically designed with the objective to meet QoS requirements.
- *QoS mechanism* define a specific mechanism that may use QoS parameters or QoS context possibly in conjunction with other QoS mechanisms in order to support establishment, monitoring, maintenance, control or enquiry of QoS.

QoS management architectures provide a coherent set of abstractions [2,9] and components in order to enable

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Dynamic Reconfigurable System Using Modular Design and JBits

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Abstract – **This paper describes the design of a dynamic reconfigurable system in an FPGA (Field Programmable Gate Array) device. The system contains a reconfigurable part, which can be configured as a convolution filter or a FIR (Finite Impulse Response) filter, and a fixed part, which is used by both filters. The design method employed combines the use of mainstream synthesis and implementation tools and the JBits tool suite. Mainstream tools allow to design at a high level, but they lack the support required for dynamic reconfiguration. The JBits tool suite allows to generate and modify configuration bitstreams for Xilinx Virtex FPGA devices. Its ability to create partial configurations is combined with the modular design flow in order to exploit the advantages of both design methods.**

I. INTRODUCTION

Reconfigurable computing is a computing paradigm that has emerged in the last decade. This paradigm allows to define the computing resources required by each application and to configure these resources onto a programmable logic device, usually a Field Programmable Gate Array (FPGA). The reconfiguration of the target device is performed under software control. In this way, applications that are computationally demanding can be executed efficiently by allocating more hardware resources [1]. Research of FPGA-based reconfigurable systems has demonstrated their efficiency over general-purpose processors and software solutions in several applications [2].

Many of the systems designated as reconfigurable can only be statically configured [2]. When *static reconfiguration* is used, the target device is completely configured before system operation begins. If a new configuration is required, it is necessary to stop system operation and to reconfigure the device before operation can be resumed.

As opposed to static reconfiguration, *dynamic reconfiguration* or *run-time reconfiguration* (RTR) allows to modify only a part of the system while the rest of the system continues to operate. Dynamic reconfiguration has several important advantages. First, it allows custom synthesized logic to be generated and configured at run-time, which results in simpler and faster circuits [3]. Second, by only partially reconfiguring the device, the amount of configuration data required and the reconfiguration time can be drastically reduced.

Although significant progress has been made in the field of reconfigurable technology, this technology is not widely used yet. The main reason is the lack of high-level design tools that support partial reconfiguration. The various design solutions for partial reconfiguration cannot be combined easily with the high-performance mainstream design tools, and usually the design can only be performed at a low level. An example is the Xilinx Java-based class library JBits [4], which allows to create configuration bitstreams for Xilinx Virtex FPGA devices using structural descriptions of the system. Currently, JBits does not offer higher-level synthesis, optimization, or timing analysis capabilities, which seriously restricts its use for designing complex systems.

In this paper we illustrate a design method that combines the ability of the JBits tool to create and manipulate partial configuration bitstreams with the possibility of designing at a high level using mainstream synthesis and implementation tools for FPGA devices. This design method is based on the modular design adapted for partial reconfiguration. We illustrate this method by designing a dynamic reconfigurable system containing a reconfigurable part and a fixed part. The reconfigurable part can be configured as either a convolution filter which uses distributed arithmetic, or a Finite Impulse Response (FIR) filter, while the fixed part is used by both filters.

This paper is organized as follows. Section II introduces the reconfigurable computing paradigm. Section III details the main design flows that can be used for reconfigurable systems: the JBits tool suite, direct bitstream manipulation, and modular design. Section IV discusses the implementation of a simple dynamic reconfigurable system to illustrate the proposed design method. Finally, Section V concludes the paper.

II. RECONFIGURABLE COMPUTING

Reconfigurable computing combines the flexibility of general-purpose processors with the efficiency of custom hardware, bridging the gap between the performance of ASICs and microprocessors [5]. The effectiveness of reconfigurable computing has been shown in several areas, such as video image processing, microprocessor emulation, encryption/decryption, or digital signal processing. The performance achieved by several reconfigurable architectures is often with one or two orders of magnitude greater than that of programmable processors [6].

The reconfigurable computing paradigm allows to improve the performance of a computing machine by defining custom computing resources based on the specific application required. Currently, these resources are usually implemented in FPGA devices. An FPGA device is an array of logical blocks whose function and interconnection can be configured by the user. Most FPGA devices use small look-up tables as programmable computational elements. These tables are wired together with programmable interconnects.

Like processors, FPGA devices are "programmed" (configured) after fabrication to solve a particular task. In traditional processors, operations are temporally composed by sequencing them in time, using registers or memory to

A General Smith-Waterman Algorithm Implementation Using the CREC Reconfigurable Computer

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Abstract – **The Smith-Waterman is one of the fundamental algorithms in the field of Bioinformatics. Several hardware implementations of this algorithm were reported, but only for some very particular cases of it. This paper presents a *general case implementation* of this algorithm using the *CREC* low-cost, General-Purpose Reconfigurable Computer. The main idea of the CREC system is to generate the best-suited hardware architecture for each software application through a Hardware/Software CoDesign process during which the aim is to exploit the high intrinsic parallelism of the application. The hardware architecture is described in VHDL code that is automatically generated by a program, written in ANSI C. Finally, CREC system is implemented in a FPGA device. The overall hardware architecture, the software code and the performance estimation formulas are presented and used to demonstrate the system's efficiency, which is close to the dedicated systolic implementations. The obtained results prove the efficiency of this CREC-based implementation and the significant gain of speed over a PC-based implementation.**

I. INTRODUCTION

The Smith-Waterman (SW) algorithm [1] is a very widely used algorithm in Bioinformatics. It represents an optimal method for sequence alignment and homology searches in genetic databases and makes all pair wise comparisons between the two strings. It achieves high sensitivity as all the matched and near-matched pairs are detected. In this field, the most commonly used algorithms are FASTA and BLASTA [2]. These are fast algorithms that prune the search involved in a sequence alignment using heuristic methods, but the level of errors yielded by these algorithms is about two times higher than the one provided by the SW algorithm [2].

However, the computation time required strongly limits the use of the SW algorithm. This is why, several hardware (ASIC and FPGA-based) implementations of this algorithm were proposed, but these implementations handle only a particular case of the algorithm, where the three parameters are assumed to have the following values: *ins* = *del* = 1, *sub* = 2 (see Section 2 for details), and there are only four characters in the alphabet (corresponding to the four nucleotides in the DNA: *A*, *C*, *G* and *T*) – as it is typical for many applications. For this particular case, Lipton and Lopresti [3] made an observation that considerably reduced the complexity of the algorithm, thus allowing high-performance implementations.

The goal of this paper is to present an application of the CREC General-Purpose Reconfigurable Computer consisting in the implementation of a general case of the SW algorithm, which seems to become a common need. The three parameters *ins*, *del* and *sub* can take any value between 0 and 15, and there are 32 characters in the alphabet. Here, the main limitation is given by the capacity of the FPGA chip. The physical support of the implementation was chosen to be a Xilinx Virtex FPGA device. Because of the generality of the considered case, the architecture occupies significantly more space in the FPGA chip than in the previous implementations. Starting from a systolic cell proposed by Yu et. al. [4], an original solution that lifts up the scalability issues is presented.

The main idea of the CREC design is to build a low-cost GPRC able to exploit the intrinsic parallelism present in many low-level applications by generating the best-suited hardware for implementing a specific application. The CREC design was introduced for the first time in [5]; the main novelty introduced by CREC consists of the combination, in a very effective way, of several design styles and architectural concepts. The result is a new computational model based on reconfigurable architecture concepts and whose main features are: *Instruction Level Parallelism*, *parallel RISC style architecture*, *dynamically generated fully scalable architecture*. The results presented in this paper prove the applicability of the CREC system for specialized computing intensive applications, approaching the performances obtained by dedicated systolic solutions, even if it is a general-purpose computer system.

II. SMITH-WATERMAN ALGORITHM

Pattern-matching problems appear in many different disciplines. Algorithms designed to solve the pattern-matching problem have evolved over time. This section discusses the Smith-Waterman algorithm (SW).

Smith and Waterman devised an algorithm for matching similar patterns. This algorithm compares a pattern *S* to a text *T* and calculates the penalty required to change *S* into *T*. Due to the fact that *S* and *T* do not match exactly, the penalty will take into account the number of insertions, deletions, and substitutions needed to convert the strings to match each other. This penalty is referred to as the edit distance.

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Interactivity in Active Objects Model

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Abstract – **Interactive application based on adaptive behavior, parallelism, cooperation, synchronization and distribution are extremely difficult to be design, developed and maintained. The active objects based modeling is one of the effective solutions. The Active Objects Model (AOM) introduces and experiments the concept of interactor. This paper highlights the interaction techniques supported by the active objects in complex applications. The research concerns on the user interaction by mouse and keyboard, the real time based processing, the operations on local files and directories, the Internet based operations, and the real process interface.**

I. INTRODUCTION

The development of computational models has progressed through phases of procedural model, object oriented, rule based, logic, and constraint based. The procedural model achieves specific tasks by algorithms and data structures. Any procedure has particular inputs and outputs. Data and procedures are public and no any protection against unauthorized access. The object oriented model is based on classes, objects and their relationships. Data is a set of objects as instance of classes. Computationally, the object oriented and procedural model are similar unless the software development performance.

All these models are static and inappropriate for dynamical simulation, animation, visual programming, multimedia, concurrency, parallelism, and adaptive behavior. The active object based model supports dynamic structure and behavior that obviously, simulates the reality better than the static model.

The research work presented by this paper concerns on:

- The interaction techniques supported by the active objects in the user interface through:
  a. Caption and processing of the keyboard and mouse events
  b. Programming and processing of the real time based events
- The access of the active objects to the computer resources such as files, directories, audio and video, and Internet.
- The active objects based control on the real process.

The main concepts and techniques highlighted in the paper are studied and exemplified through the Active Objects Model [1], described briefly in the next section.

II. ACTIVE OBJECTS MODEL

The Active Objects Model (AOM) supports the development of direct manipulation based techniques [2], [3]. The model associates a virtual location to any model entity: active object, static and dynamic variable, behavior, trajectory, virtual position, action, rule and expression. The active objects perform their functionality by a set of associated processors such as behavior, server, presenter, and interactor. The interactor incapsulates the interaction between model, user and computer resources.

The developer describes the application either as Active Objects Modeling Language (AOML) program or as AOM model in the operative memory. The program describes by AOML language the specific structures and evolutions and then is loaded and executed as AOM model (Fig. 1). The model consists of instances of active objects, behaviors, trajectories [4], actions, positions, rules, etc. Furthermore, the executable model can be saved in the AOML form as well. The AOM platform implements the entity structure and functionality (i.e. active objects, behaviors, positions, etc) and mechanisms for message based communication, synchronization, bounding, etc. [1]

The research on the AOM model focuses toward the following main goals:

- Develop a model that supports the description of dynamical behavior through the visual programming techniques [3]
- Experiment and state a consistent set of entities that supports the description of complex and consistent programming tasks [2]
- Experiment the AOM platform to support the interactivity, communication, cooperation, adaptive evolution, distribution, concurrency, parallelism, hyperstructures, visualization, hyperspace navigation, animation, visual programming techniques, and multimedia presentation (graphics, audio, video)

III. INTERACTORS

The interactor is the processor associated to the active object, which performs the user and object interaction, the

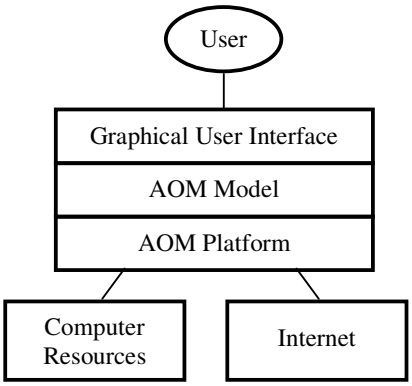

Fig. 1. AOM functional levels