Avatars: A Shifting Interaction

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Abstract

The intersection of theatre-performance, design, and informatics is a fertile area for a broader understanding of the possible design and interaction between people and avatars in simulated three dimensional information spaces. This paper outlines the theoretical modelling for the visualization of a generic avatar template applicable to information spaces. Such a representation, it is theorised, would indicate semantic and structural meanings between contents of a document collection of an information space to a person. The depiction would be mapped to the visualization engine and represented in a three-dimensional information space. Avatars require some artificial intelligence, (AI), which indicates knowledge about the structure and contents of the underlying information, if they are to aide the user in tasks related to the information system. This paper proposes that such knowledge will be represented in the geometry and structure of the avatar visualised at the interface. In this manner, the design and form of the avatar functions as a content analysis tool representing interaction between users and an information space. The grouping of such representations would lend the added benefit of a history of notational avatars tracing the user's path in an information space over set duration. Using object orientated programming, variables are attached to the body, in this case, the avatar. Depending upon the user's interaction with the hypermedia system different patterns will occur.

It is theorised that such an approach to the modelling of avatars would enhance the communication of knowledge and meaning in large data sets where recurring problems of navigation are compounded by the representation of scalability to users.

Keywords: Avatars, interactive spaces, navigation, visualization, hypermedia-databases, three-dimensional spaces, experiential design.

1 Introduction

The use of avatars in cyberspace reflects an area fundamentally rich in possibilities applicable to information modelling for hypermedia systems and pervasive computing.

Avatars have generally been recognised as navigational guides, particularly in Virtual Worlds, acting as simulated computer "personas' for users. For this reason the representational modelling of such avatars is aimed at achieving a naturalistic resemblance to the human form, or another natural form, familiar to the person from the physical world. The avatar frequently has human-like traits to indicate to the user the internal properties of the avatar. Often there is a mapping of cognitive factors as simple dramatised personality traits that the user can recognise and identify with where applicable. The ALIVE project at MIT Media Lab is an example of this approach to the modelling of avatars. (Casey, Gardner, and Basu, 1995).

It is theorised in this paper that the representation of the avatar can be modelled as a blended domain, partaking of properties from both the virtual and the physical worlds. This paper advances a theoretical basis for the modelling of such avatars focusing on the user interface of Information Retrieval Systems (IRS) and navigational interaction techniques. The interaction model at the interface emphasises interaction techniques between a person and the computer simulation of an avatar as a retrieval and search method for large information spaces. It is proposed that the modelling can be perceived as a collection of entities and aggregates (count, sum, average) of some property of the avatar objects, based on analysis of content description. The visualization of the avatar would represent this content description in the structural and visual design of the avatar form at the interface. The form would inherently reflect the function the avatar is performing in the interaction design as the changer between the user and the system .

2 The Aims

To develop software that support user interaction with large-scale hypermedia databases. To design dynamic tools for retrieval and search methods represented as the structural and conceptual form of the avatar. These tools would assist in the finding of information in databases, and the viewing and interacting with information objects. To formulate design strategies within the avatar design that accommodates collaboration between users and indicates forms of navigational directives, the depictions of which indicate knowledge of other users. Such a presentation, if collaborative, can be perceived as a form of virtual theatre represented as a series of notational avatars, providing a visual-kinaesthetic "script" of users' interaction within the hypermedia system.

Recent directions in Human Computer Interaction (HCI) support such an approach. For instance Chalmers, 1999, considers informatics. a component of social interaction, addressing the complexity and the context of interactive design.

3 Three Dimensional Database Environments

The growth of the World Wide Web (WWW) and its open architecture creates an opportunity for the development of shared large-scale 3D spaces. However this brings up issues of scalability in the design of such spaces. Large-scale hypermedia databases provide an example of such a problem for navigation or way finding, and general grasp of semantic relations for a human user. The traditional approach to providing interfaces to databases has been primarily through a number of textual language interfaces such as SQL, and NOODL Such interfaces can be reasonably opaque to non-programmers and do not necessarily map satisfactorily to multimedia documents such as video and audio.

One way to introduce greater transparency of design for the user, when s/he is attempting to browse/search large hypermedia document collections, is to design software for interactive three-dimensional spaces. Three - dimensional spaces are a natural medium for software agents and the scoping of new paradigms for the modelling of agents (Nakanishi 1999). With the increase in computational power and the availability of high end graphics workstations it becomes possible to design graphical, multi-sensory, interfaces that support multiple configurations from a set vocabulary of terms with attached contextual rules. This would enable the user to customise the interface to their information needs.

3.1 Definition

A large-scale (hypermedia) database is defined in this paper as one"which is too large to display and search in its entirety, in real time" (Brown 1996).

4 Metaphorical Mapping and Blending

The conceptual basis for the design of the proposed avatar is provided by an analogy to theatre and dance-theatre as the basis for the mapping.

This analogy is one based on the function of a performer in the theatre, reflecting the simulated character and design of a character through actions (oral, kinaesthetic) to an audience. The performer is in a middle realm between the "real" physical world and the formalised imaginary structure of theatre. The codification of the performance rests upon an agreed vocabulary and contextual linkage with rules to this vocabulary. It is situated in time and often indexed to a specific spatial situation. The semiotics of the performance is communicated to an audience through the agreed vocabulary which may require certain augmentation. Such additions can take the form of topographical indicators such as lights, costumes, music, accompanying video etc. The resultant "blend" for an audience will be a mix of all these inputs with each individual's conceptual framework.

This analogy forms the basis for the conceptual modelling of the avatar. The form of the avatar is coupled to the function being processed related to the navigation and accessing of information. As in theatre dance the resultant presentation will indicate spatial design communicating lines of direction and relations to other objects This is communicated at the interface (the presentation), through the expression and behaviour of the avatar.

Placing the avatar design as a communicator of change between the user's needs and tasks, and the system design means the avatar has to indicate properties of both worlds in its representation. The form and behaviour of the avatar has to blend the needs of the user with the information structures in the space and project these onto the user interface design. The avatar depiction would need to be re-configurable being modified by changing contextual relations from both the user and the system design...

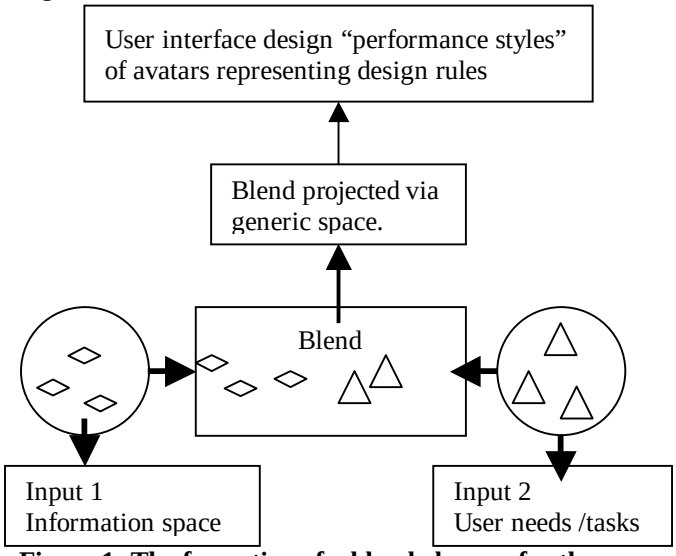

Figure 1: The formation of a blended space for the design of the avatar projected to the user at the interface as design configurations with rules. (Adapted from Fauconnier (1997)

Fauconnier (1997) indicates the importance of context in the determination of conceptual blends that arise from conceptual integration. He states that a blend emerges from two or more input spaces, a generic space, and a blended space. Blended domains can give rise to novel meanings. The structure that emerges is something else and is somewhat independent from the meanings from the original domains. The proposed avatar design like a performer functions as a blended domain placed in the middle between two worlds.

The criteria of the avatar referencing theatre-dance, is structured around a central motif the human body, to which meanings are attached and or projected onto. Theatre-dance places the body as the central symbol upon which structural information is scripted. This information can reference the text of a play, gesture as in codified movement, or visual display as in lighting, costume, and so on. The body becomes the pivotal object to which are attached interchangeable variables and behaviours that mutate depending upon the context. The context is framed, essentially, by the terms of the performance. Depending upon the situation, the behaviours and structuring of the presentation will differ.

Taking this analogy back to an information space it can be proposed that the mapping of the structural and

semantic relations of an information space by the avatar design as a response to user needs provides the contextual framing for the resultant "performance" of the avatar.. This analysis of the avatar references work done in cognitive science specifically the construction of meaning through image schema (Lakoff and Johnson 1980, Johnson 1987)

4 Representation

When such a conceptual blend forms the basis for the conceptual modelling it indicates a shifting representation as the semiotics change in run time. An inherent problem of the avatar design is connected to this changing depiction of the avatar. To a user such changing appearance may be perceived as confusing even if transition indicators are keyed into such morphing of appearance. Context sensitive relations as when people in the physical world adapt their interaction to different social environments may indicate representational design strategies. Such relations indicate a series of avatar designs modelled as instances from a super class. These instances function as notational representations of user profile at set duration.

The depictions are schematised so that they reflect general, summary properties of the entities that they convey not detailed, analogue properties. This relates to granularity in the representation of the avatar. As the representation of the avatar indicates movement towards finer detail in regard to set of documents the design elements take more specific form and the schematisation of elements may be sharpened

To design and model such a representation, some fundamental issues require attention. These are to:

- Determine the levels of the avatar architecture and the interaction paths from one level to another.
- Define what sensory information these layers of avatar architecture have attached to them and how such outputs are conveyed to the user.
- Design the channels of communication between the avatar to the human user and from the avatar class to the information space.

5 The Avatar Performance

It is proposed that the avatar conveys navigational pointers to the user in response to user needs and activities. The design performs actions that point to documents and relations between documents in the information space. The user responds to these schematised pointers presented at the user interface design. The response is organised by design rules modelled on the dance theatre criteria attached to the avatar at any one time. The user by modifying their information needs shifts the context and the avatar re-presents the design at the interface ii response to the new situation.

The avatar's function is modelled on information storage and retrieval system's relationship to a collection of documents. In such a system, a standard way to describe information objects is to use a surrogate to represent an information object. The surrogate represents the information object but is distinct from it. The surrogate to maintain connection to the information object it represents needs to have some identifier(s) that link it to the object. In the proposed system the avatar class becomes the surrogate standing for the information objects. The descriptors are modelled on movement directives. This gives the potential for spatial configurations to emerge as the avatar maps the information space pointing to relations between information objects. The avatar class in schematised form describes the contents of the document collection and relations between documents. .The design indicates an alternative to index based approaches to information retrieval. Instead the avatar design places navigational information as a means of connecting and mapping relations between objects in a space. The design criteria further indicates that the identifiers can be based on kinaesthetic and visual cues giving lines of direction, and interaction directives to the user by the user interface design. Such navigational techniques aim to maximize the amount of information perceivable and appropriate to the user's need.

The proposed design extends the functioning of surrogates in traditional information and storage systems (ISAR) to encompass an interactive control system of the animated avatar. The avatar changes the descriptors attached, which are codified as actions, in response to contextual cues. It re-assembles its form as a depiction of the identifiers it is representing to the user as one particular event. Careful modelling of dimensions is required if successful mapping is to occur.

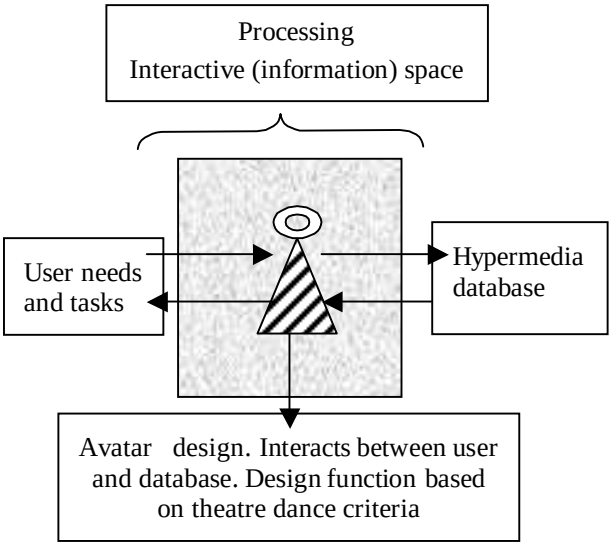

Figure 2: Avatar design becomes the suurogate. Transformation of binary bit pattern of hypermedia to formal symbol system of the avatar.

In figure 2 the avatar acts procedurally. The computation can depend on the immediate context- including user-initiated actions, time, personal information about the user etc. The context, the processing area in figure 2, can change quite rapidly as semantics are formed. The avatar class performs (depicts to the user) directives as a series of actions within this context.

For this paper it is considered that the design representation of the avatar at the user interface level requires a number of actions to take place within the avatar system. An action is defined here as any change in the avatar representation that is contextual. For instance, acting as directives or pointers to a server to initiate some computation.. Interestingly this is similar to recent research in Media Arts and Sciences (Pinhanez 1999) who based his definition of an action upon that of (Bobick 1997). Bobick views an action as a movement happening in a context. The question then becomes how to represent action? ([Pinhanez,1999). For this to be translated into the avatar design two aspects of the representation of the avatar require consideration.

-the context the avatar class is representing to the user.

-the movement in the design of the form of the avatar or avatars and how this change represents a reciprocal change in function..

5.1 Context

Context is generally the situation where the movement happens. A change in context would produce a change in the associated action (Pinhanez, p33 1999). The context is coupled to the task being performed, browsing or searching. the user's need, the domain, the structural design of the datasets, and the physical storage design at the database end. Since these factors vary considerably no definitive examples can be given in this paper. For instance domain differences with a particular system dedicated to it will account for variation in user tasks Applying this to the scope of this paper, the activity of searching, for example, will present different contexts to a user when the action is searching a structured database then when searching the World Wide Web (WWW). The action is modified by the change in context. The *pattern* of such action, which becomes the symbolic representation in the form of the avatar class at the interface, will display different design structure as a representation of the different interactions.

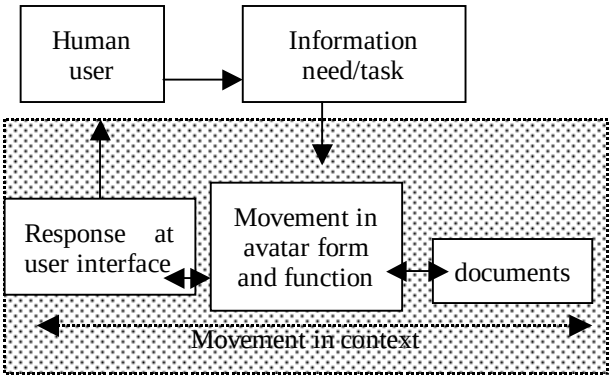

Figure 3: Design for an interactive space

Figure 3 indicates the relationships between the avatar, user, and documents when an action, for instance, to retrieve documents is initiated. The avatar "moves" between the documents and the user shifting the representation in form to accord with the shaping of the function that is being performed. The avatar matches the user need to held descriptors and displays results in the information space accordingly.

6 Movement in the form of the avatar

It is considered here that a change in representation constitutes a movement, as it is a movement from a structural to a symbolic representation. This is the same as a change in the form of a performer in the theatre, or in a dance, (costume, gesture), indicating to an audience a translation of that performer's function within a certain frame. This frame would be determined by certain formalizations, for instance, length of scene, phrase of movement in dance-theatre as measured by spatial design and/ or time, or length of text. A frame could "hold" a number of such formalizations or codified instances. Sequencing and the relations between the sub-components would carry symbolic content.

Applied to the design of the avatar this would include any change in a state related to the representation of the avatar. Modification in the form, behaviour, and therefore function of the avatar, resulting in changes in the patterning of the avatar, can be moved from the processing component of the system design to the output channels in the system. Sequencing and the relations between the sub-components are intrinsic to this representation of change. Sequencing indicates an ordering of components by some application of structural design and contextual formalization. Which sub components are linked, in what order, and whether these components are modified by attached variables, for instance velocity, determines the structural design of the avatar. The form and function of the avatar are tightly coupled in the design.

7 Sequencing and Sub Components

The two levels of avatar architecture that map the representation to the visualization engine are sequencing and the breakdown of a pattern of movement into the ordering of the patterns' sub-component parts. If, for instance, the movement is communicating to the user the structuring of relations in a particular information space, then this *process* needs to be visualized in the representation of the avatar.. To do this requires a representation that accommodates a re-configurable vocabulary the rules that are applicable to the ordering of these parts giving the resultant sequence. Such rules would be dynamic and contextual. Figure 4 indicates an architecture supporting such a configuration.

This is a bottom up approach to the design of avatars. Layer 1 is the vocabulary level. Here would be determined the granularity of action and the scale of the vocabulary. Level 2 determines the configuration of the combinations of sub components. These could be perceived as sets or phrases. This level does not, however, determine the dynamics of the actions. This is represented at level 3 where the order and temporal length of each component is measured against a determined interval pattern. This gives the sequence. In turn this sequence is passed to the visualization engine and then presented at the interface for the user as a response to a particular profile instance.. An instance could be a number of search queries or a specific search formulated by the user. It could also be a concept map of document collection, or any form forming a sequence of

patterns identifying relations between documents for users. The length of any instance would require consideration.

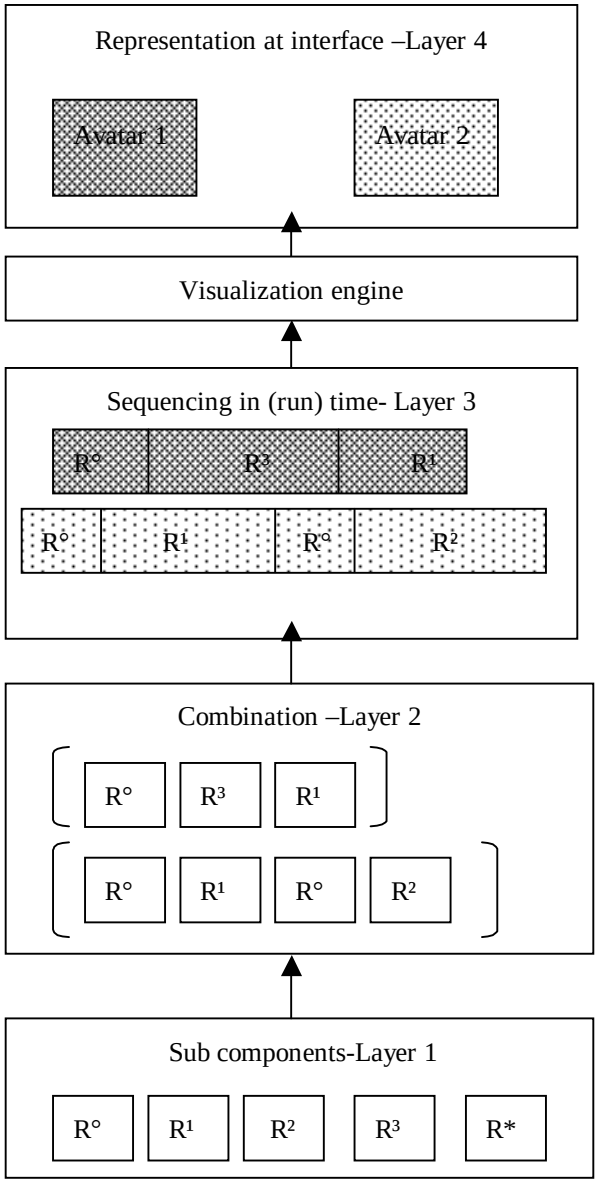

Figure 4: Avatar Architecture showing how a re-configurable vocabulary could lead to dynamic representation

This avatar architecture provides for multiple representations which would, it is suggested, better support user tasks. The added benefit of such an open ended approach to the avatar design is the ability to output multimodality if appropriate. A "score" of avatar instances could then be used in navigational design aiding users in choices guided by the appropriate directives attached to the avatar. or avatars. This gives a design solution in the proposed design to diversity of user's tasks. Accompanying interaction between avatars presenting collaborative patterns, could also be an extension form such a modular architecture. Such interaction would be a means to collaborative structuring of meaning and navigational information for users accessing large hypermedia collections.

There has been considerable research done in this area related to the visualization of spatial design in cyberspace. The way that elements are arranged in space, in groups, orders, or distances, can be meaningful, either iconically or metaphorically (Tversky, B., Lee, P.U., 1999). Depictions of all kinds can be separated into elements and the spatial arrangement of these elements. The elements will change, being contextual, the sequencing being represented as an action placed into an agent. The sequencing of the sub-components of what constitutes an action in the associated context can be conceptual or spatial or both.(Tversky,1999). Depending upon the three dimensional space the user is navigating some of these depictions, may be meant to reflect spatial relations in the real world; or for more abstract depictions, the spatial relations may stand for non-spatial relations such as semantic content between documents.

8 Actions and Large Hypermedia Databases

Based on the avatar architecture in figure 3 it is proposed that there are two main possible applications of the avatar design at the interface level. One is to present the avatar representation as a singular event the other is to convey information to the user via a number of avatars. The context would impact on which style of avatar was visualised. There can be one or many avatars, or one avatar can represent one or many events, or many avatars can represent a single event.

This indicates the structuring of patterns based on the movements *between* avatars, between avatars and other objects, as well as movements occurring within each body as a discrete event. It is proposed that the design of the avatar and the organisation of a number of avatar symbols within a spatial context (that is, as a pattern) would communicate to the user information in regard to

- organization of the hypermedia collection- i.e. is it hierarchical, semi-hierarchical, or unstructured.

- relations between nodes –which are parents and which are children.

- interpretation of the structure (avatar acting as a filter) for example a tree structure of a book would be displayed in the pattern normally accessible by the book. It would be interpreted as a pattern of a certain logic representing the manner in which a book would be laid out.

- identifying for the user how each structure is characterised by having a collection of substructures, each organising destinations into sets, sequences, or maps. This action provides the sequence for any particular context.

What is suggested as being communicated to the user is keyed to an action. These as indicated above are, organization, relating, interpreting, and identifying. Referring again to figure 4, it can be argued that the proposed architecture, due to its layered approach and configurable vocabulary, can support these core communication "acts" and could convey them at the interface to a user.

The rest of this paper will discuss the components in the avatar design as a re-configurable vocabulary, and the application to patterns both as singular and as collaborative events. A brief generic example related to the activities of navigational tasks will be given.

9 The Avatar

The avatar class represents an object blend structured with a core class <body> to which <actions> and <modifiers> as variables are attached. This indicates a grammatical logic that can be used to aide the user in structuring relations in cyberspace.

If code objects can be thought of as "real three-dimensional" bodies (objects) then the avatar objects with attached variable descriptions can be mapped to a re-configurable structure depicted as the visualization of the avatar. As such the (avatar) body would have structural design, (motif description), events (behaviours here identified as modifiers) and capabilities for communicating with the 'world' around them (methods-here indicated as actions.) A similar logical synthesis has been noted by (Maher, Simoff, and Ciognani 2000). These activities generally infer relations between slots from one object to another. Identifying the categories of knowledge that specify an action, body, or modifier enables one to then determine the relations between these categories and the resultant patterns represented by these relations.

Applying this to the design of the avatar class, there are proposed three slots for each avatar object, "structure", "action", and "modifier". Each of these slots can refer to another object. In this way there are relations between the objects and their accompanying slots. Any movement consists of a combination of such in various manners. These categories are based upon the analysis of movement as outlined in the system of recording movement known as Labanotation (Hutchinson 1980).

The design of the shape and interaction between parts in the avatar is referenced to anatomical structure. Relations can only be established relative to the structural parameters of the parts within the system. Each avatar sub-class can modify the anatomical structure to some extent to re-configure the body to indicate different or new semantic relations. The grammatical logic is based on the semantics conveyed by the avatar at the user interface design. The purpose is to bring representational significance to arrangement and location of abstract sets of information. (Wexelblat, 1991).

10 Avatars as Bodies

The core class body is the object to which the actions and modifiers are attached as a contextual act. Bodies are the objects in the spatial environment to which movement occurs. There are two levels of the body class. Independent bodies in a defined space/frame that frame their representation within the boundaries of each body's form, and bodies which "build" relations between information objects collaboratively. These act as semantic indicators displaying connections and behaviours patterns between information objects.

The class <body> indicates the geometry of an object. Is it a primitive (cube, sphere, cylinder, cone, torus,) or a complex body? The body can be segmented and jointed, with various degrees of freedom associated with the "anatomy" of the avatar. Such a design is modelled on a plastic anatomical system such as the human body. The system is organised on hierarchies consisting of relations like part-of, is-a, branch-of, tributary-of and contained-in. The avatar consisting of a single root term body (for the part-of hierarchy) organises its structure as successive layers of children. These consist of finer level of details of terms and are the modifiers and actions.

The texture or wrapper of the avatar body can also be modified indicating semantic dimensions via the mapped classification properties. Textures can be sequential, indicating a linear progression with a defined starting and end point, (moving from light to dark /black to white or sequences may be relational. Properties can only be determined by examining relationships among the objects or relationships between the user and the object. These kinds of dimensions need to be represented generally as parent-of or is–a, or is-called-by. In a hypermedia graph arrows have been generally used to show such properties. In the avatar representation proposed, which is three-dimensional, such relations would be translated by the body class calling the appropriate action to express such a relational dimension with modifier (s) attached where necessary. How many objects would be made from the avatar class would depend upon the number of instances of the class required.

11 Avatars as Actions

The avatar architecture outlined in figure 4 can be modelled as an action diagram. Each level of architecture can be described in terms of the (main) action or movement relation. that occurs for that layer to be operational.

Such action architecture indicates a number of layers that can be called by the avatar creating a sequence of actions. The sequence would be re-configurable, depending upon the context and the activity the user is supporting at the time. It is proposed that actions and the ordering of such would be different depending upon the user tasks being processed..

As noted, the configuration of the avatar would be modelled at the singular and collective levels. Patterns that call upon a number of members of the avatar class, would present relational information, the dimensions of form measuring nominated semantic dimensions. The function of such group structures is to indicate to a user a conceptual overview of a hypermedia collection and the structuring between documents. If the avatar representation is supporting the user task of, say, navigating by the quickest route between point A and point B then the user interface design would indicate lines of direction in the avatar form to support the task. If the user wished to browse between points A and B to gain some overview of content analysis then the avatar design supports lines of direction, plus relations, with the addition of dynamics if terms were weighted in a particular domain.. A relation would be a turn, a jump, or

possibly a slide. Dynamics would indicate the weight of movement accompanying a path between two or more points, or attached to velocity.

If the user needed to interact with an information object in the information space to pursue an information need this also would be directed through the avatar display by selecting, joining and ordering the appropriate vocabulary module. The proposed design supports such mapping of user tasks to navigational outcomes through an accompanying avatar acting very much as a personal navigational tool. This means there needs to be a number of avatar 'styles" that the avatar class can call on as required..

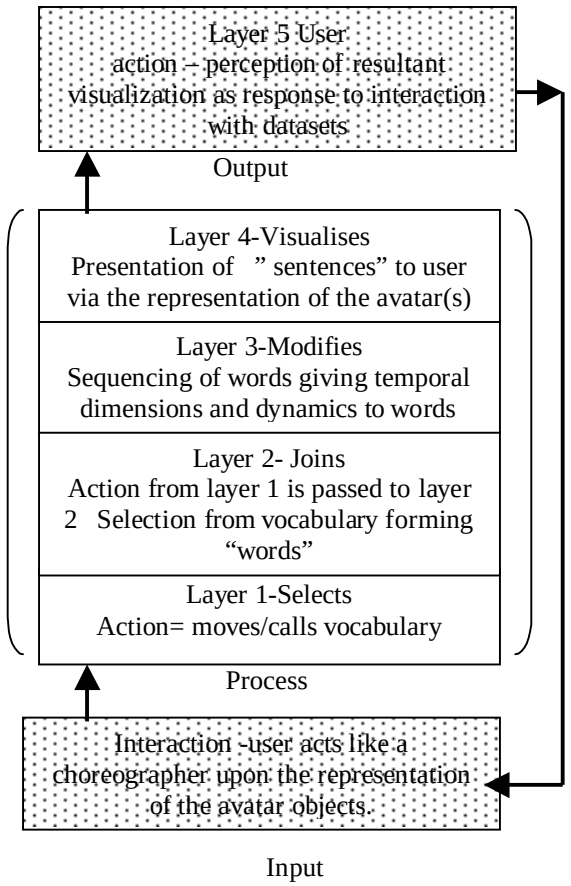

Figure 5: Action interaction architecture for avatar representation. Three stages, input, process, and output.

Very broadly, it is proposed, that certain predominate characteristics of patterns in a three dimensional information space could be mapped as representative of different hypermedia graphs. The dimensions for such patterns are indicated in the spatial design of the information objects and the attached links called by each node.

A hierarchical tree structure would indicate an avatar pattern organised around strict rules with determined paths between nodes. Avatars could only pass attributes in certain formations indicating underlying linkage structure. A semi hierarchical structure would have a looser configuration not necessarily a tree structure. The key node may be placed spatially at variance to hierarchical structure, which generally favours a top down approach or a left to right structure. A semi hierarchical collection may radiate from a central node or may have a number of parents with attached children. This would lead to a different mapping for the avatar class to present to the user. Again the transference of attributes would be modified to parallel the linkage paths in the documents. An unstructured hypertext system would indicate a different representation again with possible divergent paths and less or possibly no ordering between documents. Semantic relations may be obscure. The avatar collaborative design would map these structural components as relations with few intersections, little partnering, and joining, and possible divergent paths in the passing of attributes from one object to another.

12 Avatars as Modifiers

The structural design of the avatar needs to be able to be modified to represent behavioural patterns. Behavioural patterns indicate how the objects (avatars) interact and how the presented pattern is modified through the application of dynamics. This is of fundamental importance when semantic relations between documents are being "mapped" in the avatar pattern. The modifier also scopes the interaction between avatars delegating responsibility.

The modifier class adjusts the action class, and or, the body class, with resultant change in the avatar's representation. For example the action, move, needs to be modified by direction, which could indicate movement from the central node to periphery. In data mining drilling down is fundamentally different to 'rolling up" or "sliding across".. Modifiers in such a context represent tight coupling to the dimensions and scale of datasets. An action may need to be repeated, or allocated a dynamic, such as fast or slow, modelling through this expression information on the hyperlinks.

13 Visualization Techniques and Semantic Dimensions

It is important to scope what the visualization aims to represent, from the hypermedia graph to the user, and what can be ignored or maximalised. This proposes an approach to software design that focuses on transparency for the user at the interface.

The aim is to support navigational tasks and needs in different domains as key activities for the user. The modelling of the avatar class would need to consider how to scope the representations for different tasks.. To cover such activities several different "performance styles" will be required to support such variety of user needs in large information spaces. Visualization of these user tasks which can be essentially different, indicates some form of hierarchical selection in representing information. Any visualization would form a sub-set from the database, the pattern of which would vary depending on the whether the database was hierarchical, networked, or relational. Again it is important to emphasise that this paper is proposing a generic template for the avatar design and cannot cover in detail specific applications of the design. This will be covered in the next stage of research.

14 Navigational Tasks

When a user enters an information space they either are looking for a specific target or they are exploring and gaining by such activity some view of the contents within the space. The form of the avatar varies from one activity to another indicating, as noted above, the configuration of two avatar "styles". Within each of these styles there would be a number of generic instances called for particular situations. depending upon the system design underlying the domain.

Table 1 and table 2 outline the function and form for the basic hypermedia activities of searching (looking for a specific information object) and exploring (browsing).

It is proposed that when the task is to indicate to a user semantic relation in an information space, the avatar group formation as a pattern, becomes an indicator of structural and semantic relations for the user. Such group indicators of spatial design, orientation, and main directional lines would represent for a user key aspects of the domain. The user interface display would represent a different configuration for a hierarchical collection of information objects compared to a relational or semi-hierarchical collection.

Activity	**Class**	**Function in the avatar**	**Form in the avatar**
Exploring/ Browsing	<action> Examples: join (clustering) move (hyperlink) <modifier> speed (fast, slow) direction turn <body> structure (primitive, complex) number .of facets)	Show linkage Show main lines of direction Show interaction objects, and interaction between objects	Show linkage Show main lines of direction Show patterns of interaction to objects, and between objects

Table 2: Indicates some generic actions, function, and form, for the activity of specific information need.

Basied on (Gloor 1997) the main design concepts for navigation in cyperspace can be outlined as limking, sequentialization, and similarity or clustering. . Again in table 2, where the activity is searching the avatar models itself on key aspects of this activity. There would be a shared vocabulary between these two activities, the difference from one activity to another becomes an inherent design issue represented in the ordering of the component design elements in the avatar.

Activity	**Class**	**Function in the avatar**	**Form in the avatar**
Searching/ specific information need	<body> one colour pattern classified <action> call drill roll <modifier> direction (up, down, etc) relation (e.g. turn)	Points to specific objects Conveys directional lines and planes Indicates weighting in space	Represent relations as semantic, structural, in the behaviour and structural design of avatar form.

Table 2: Indicates some generic actions,function and form for the activity of searching

For large document collections a user would be changing from one activity to another tracing a series of patterns in the information space accordingly. A history of avatars would be a record of a users' interaction with an information space.

15 Mapping Issues

In the hypothetical example given below, each graphical indicator of a node related to the query is assigned an avatar. Similar representations indicate semantic proximity, while dissimilar forms would symbolise the opposite. This schematic depiction as an overview indicates patterns of form appearing pointing to semantic relations between nodes. When behavioural actions and modifiers are included in the representation the avatar carries multi-sensory information to the user.

In figure 5b, the body of the avatar form is mapped to represent different relations in a document collection. The target node (A) and close semantic matches (A^1, A^2, A^3) are differentiated from other nodes by the core body form. A further level of the conceptual structure is given in topographic indicators depicted on the body: for instance adding tone, pattern and colour to map landmarks between nodes. The central node form shows three different tones indicating degree of similarity. The further semantic relations move from the target node the less similar the depiction of the avatar form becomes. Parent child structures are indicated in this generic example by decreasing one dimension, width, in the body of the avatar. Obviously such a depiction could be modelled in numerous ways to represent semantic relations. The main aspect of this example is to propose how the avatar design can integrate knowledge about different routes to infer nodal relationships.

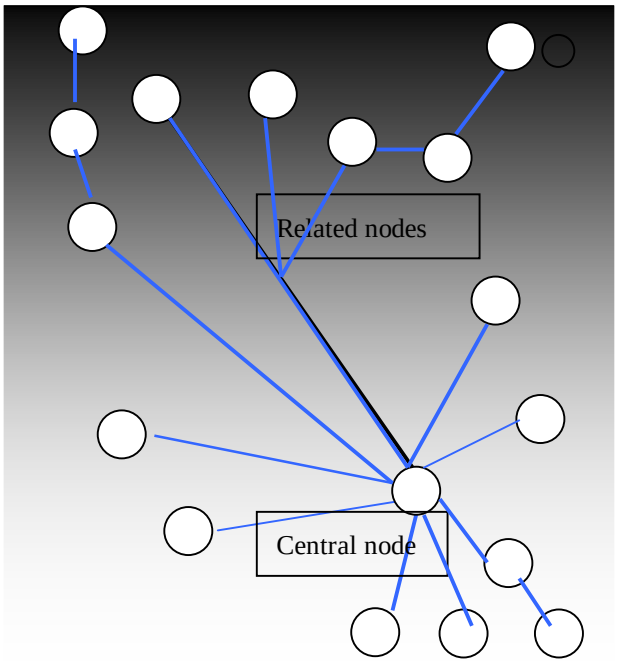

Figure 5: Basic hypermedia structure of nodes and links.

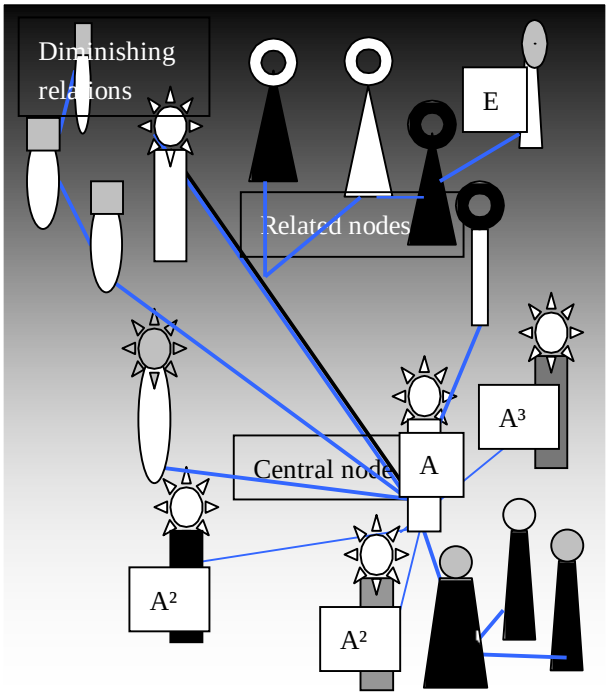

Figure 5b: Hypermedia structure depicted as schematic body structures in the avatar design indicating semantic relations between bodies.

Compare this to figure 5a, where distance is the mapped dimension for semantic proximity. This basic graph does not depict the kind of relation between nodes (similarity/dissimilar) indicated in figure 5b. Neither does it depict the possible collaborative representation that could be an outcome of design patterns suggested in figure 5b.

However the depiction in figure 5b, could only be used to represent broad relations for a user. To expand the representation of the avatar sub classes of modifiers and actions would need to be called. The modifier class by adding dynamic information to the representation could indicate the speed of different routes. Whether a node could be reached faster by another route (A, ?, E) or from somewhere else in the network (? E). .For the purpose of this paper the example has to emphasise the display of visual properties for the user interface. It is proposed that this would be extended in an information space to include representations of kinaesthetic relations as conveyors of criteria of the avatar design.

Placing this proposed design in virtual reality, three-dimensional spaces become a translatable medium for avatar collectives. Such spaces could indicate pointers from one document to another, hyperlinks within a document and from one domain to another, or in the case of VR, from one "world" to another. Patterns could become a method for storing context, a form of history /book marking for users in hypermedia. Such cognitive maps of users interaction with the hypertext could record behavioural and dynamic interactions of a human user.

16 Conclusion

The challenge for the modelling of the avatars is to express through the pattern of the representation (which can be argued is a language if formal rules are applied) a language that expresses both data and rules for reasoning about the data. This of course connects to research on the Semantic Web –adding logic to the web, the means to use rules to make inferences, choose courses of actions, and answer questions. For the design of the avatar it is important for the user to understand what the representation of the avatar means in regard to the nominated domain that the user is searching. This indicates that domain knowledge has to be able to be mapped through the design of the avatar to the user interface design. Such an approach promotes synergy; agents can transfer data among themselves as long as the data comes with semantics.

There is the issue of heuristics and the representation. If the language for the rules is made as expressive as possible, enabling users to reason widely, the structure (s) may not be totally predicable and could have paradoxes. However the proposed design addresses two main aspects of spatial cognition and hypertext. Namely that virtual and physical space has different properties. It is not always possible or appropriate to map Euclidean geometry, the geometry we are familiar with from the physical world, to virtual spaces. For the user to gain some form of cognitive map of a domain it is important for the avatar design to reference a vocabulary of sub components that the user is familiar with from the physical world. Such familiarity enables the use to create a concept map of a particular domain...In the proposed design the avatar builds its vocabulary from bodily movement relations. It is suggested that the user will have an understanding of these same principals based on a bodily intelligence supportive of an intuitive access to content. .An implication of this is that the cognitive representation influences how people reason about space an din what order they choose to interact with situation within an information space.

The movement events in the depiction of the avatar essentially couple actions with particular environments, supporting the view of embodied cognition that objects in the world are understood not only by visual extraction of features but also by the visual guidance of action (Varela, Thompson, Rosch 1991) . This underlies the construction of spatial organization without which there is no semantics (Shun,1990).

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