DYNAMIC DATA PRESENTATION AND THE WWW

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ABSTRACT

Maps are increasingly being used as a primary real-time visualization tools in an interactive and dynamic environment. They are being used to explore geospatial databases that are hyper-linked together through the World Wide Web - an environment that has enabled access to a variety of dynamic, linked object forms that depict geo-referenced information. For geo-applications that engage in acquisition and distribution of frequently changing geospatial data, the Web suffices as one of the suitable mediums to communicate and explore geospatial information in an economical and efficient manner. An example of a geo-application that could possibly exploit the Web's potentials is in weather information presentation and forecasting. In this paper, we pursue ways of intuitively exploiting the diverse sources and weather data formats available on the Web to compile weather maps for both novice and technical users. We use interactive animations whose functionality are embedded with domain knowledge that can dynamically characterize, track weather patterns, resolve conflict situations and enhance features for presentation purposes. The developed animation functionality are generic and could as well find use in other related geo-disciplines.

1 INTRODUCTION

The Internet, and more particular the World Wide Web (WWW) has become the vehicle to disseminate geospatial data. A country’s geospatial data infrastructure would not function without. A method to assist the distribution of geospatial data is the use of maps. They can function as an interface to (geo)information in cyberspace or can guide the user navigating the WWW. In the first role it provides access by clicking objects, and will bring the user to other web pages, which can contain again maps, photographs, text or downloadable data. In there role of guiding the user through parts of cyberspace maps will help to keep track on their path through for instance a single website. Of course maps can still function as they did before. They can present a message by showing geospatial patterns and will increase insight in geospatial relations. In all its functions the maps specially profits from the WWW’s capability for dynamics and interaction. This results in new mapping techniques as well as new use possibilities not seen before with traditional printed maps and most on-screen maps. Most successful applications are those offering time-sensitive geo-information, such as the weather or traffic. Also popular are those sites that allow one too interactively compose location or route maps.

In their book on Web Cartography Kraak & Brown (2000) apply a web map classification based on how the map image is used according the keywords interaction and dynamics. Their approach distinguishes between non-dynamic and dynamic web maps. Each of these categories is further subdivided into view-only and interactive maps. The most common map found on the WWW is the static view-only map. In most cases these are scanned existing paper maps. The interactive version of these maps is the so-called ‘clickable’ maps. In this case the map functions as an interface to other data. Interactivity could also mean the user has the option to zoom and pan. However, the WWW is very suitable to present dynamic (geo) processes. The changing geospatial data can by presented by animation.

Despite these capabilities, animated maps on the WWW still lack the intuition and user-friendliness of enabling users to assemble, update, compile, and interpret domain information. At present most maps come pre-packaged with limited interactive capabilities for controlling the play and little of any to manipulate the animation's content. This is partly due to the nature of the source data and the fugitive nature of the animation, aspects that make it difficult to analyze and interpret the data. In this paper we pursue means by users can be empowered to select as well as decode relevant domain data or, compile and interpret domain information. We do this by use of interactive animations that are imbued with domain knowledge, thereby enabling them to make decisions during run-time.

2 WWW AND THE ANIMATIONS

The World Wide Web (WWW) is facilitating the use of maps as primary real-time visualization tools in an interactive and dynamic environment. Here they are being used to explore geospatial databases that are hyper-linked together through the WWW (Peterson, 1997). The WWW as an object-oriented environment supports access to a variety of dynamic, linked object forms that depict geo-referenced information. It similarly supports both interactive and dynamic tools that can give access to hyper-linked documents. Data sets that can possibly exploit the WWWs abilities are ones that are posted updated and accessed frequently from multiple physical locations. Through it, maps can be delivered to the users within a shorter time than with the traditional paper maps.

Researches in cartographic animation in general and those linked to the WWW are seen in ICA (1995), Cartwright et al, (1999), Peterson (1995) and special issues of the C*artographic perspectives (Vol.26, 1997), Computers and Geosciences, (May 1997)*, *Cartography and GIS* (*Vol.2, 1999)* respectively. The WWW enables the distribution and display of cartographic animations on virtually any computer, anywhere (Peterson, 1995). The WWW also provides a conducive environment for implementing animations as it enables the design of manipulable animations with the user having control of the direction, pace and other animation design elements (Peterson, 1999).

2.1 Types of animations in the WWW

Early versions of animations were the animated GIFs (Graphic Interchange Format). Here sequences of images stored as GIF images are streamed on to a page to create a slide-show-style animation also termed *frame-by frame* animation. They are easy to create and view and need no programming or plug-ins. AVI (Audio Video Interleave) is an Audio/Video format for Windows. It uses the k*eyframe* technique for animations, where only the most important frames are saved, and the in-betweens calculated. Director shockwave similarly uses *keyframing* technique of animation production. Other animation formats are the MPEG (Motion Picture Experts Group) and QuickTime movies, both having the ability to handle sound and video files over the WWW. VRML (Virtual reality Modeling Language) supports 3D animations, which can be hyperlinked from within the scenes and facilitate user interaction with the objects therein. Initially, most of the animation formats required players or browser plug-ins to be installed on the end-viewers side of the system, a trend that has since changed, as many Web browsers have them embedded within as defaults. More compact, platform-independent programs that download and execute on the client side of the WWW can be composed using JAVA-Script or JAVA programming language. Using JAVA one can create a computationally, interactive animations. It supports the production of *algorithmic* animations, where objects, their properties and paths or trajectories are defined based on some geometric expression.

From the above types of animations, we distinguish between *playback* (*view-only*) and *interactive* animations. *Playback animations* are the most common. They are passive in nature with minimum interactive ability and are mainly used for presentation purposes. These animations are pre-designed well in advance and posted in the WWW for viewing only. They are meant to run with little or no interference from the viewers. A legend will normally accompany the display. The viewers can not modify the sequences of the frames *(URL 1).*

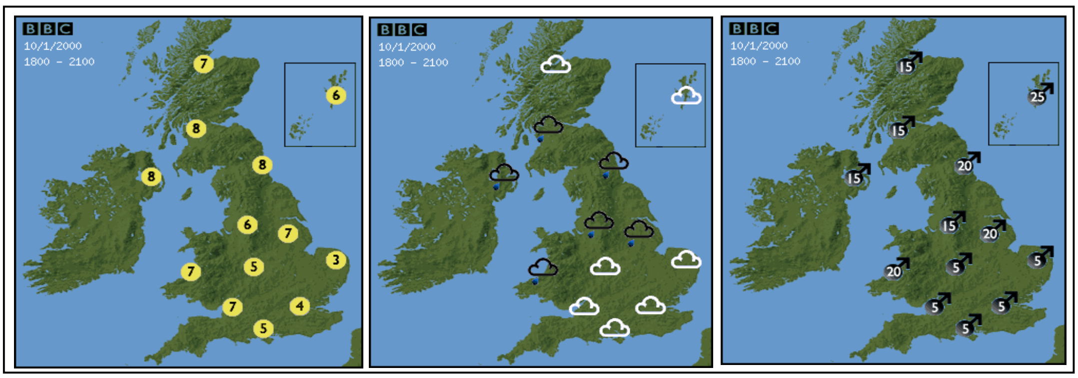

Figure 1. Accompanying graphic symbols depicting different aspects of the weather (source: BBC weather Website)

Interactive animations employ varying means by which the sequences of frames and their contents can be modified. This can either be effected directly onto the features in the frames or indirectly using the interface tools. The *directly* interactive animations go beyond just providing the media player controls. Additional controls in form of active legends, and switches for turning layers on and off during plays are provided *(URL 2, URL 3, URL 4).* The *indirect* interactive animations deploy varying levels of interaction between the user and the animation.. They can be used to communicate existing knowledge, thus their nature encompasses media player control tools to start, stop, pause, fast forward/rewind the dynamic display effected by either command menus or buttons *etc (URL 5, URL 6, URL 7, URL 8).*

A better stance than barely giving users control from pre-determined paths of animation frames, is by involving them in the selection of thematic and animation attributes before animations play *(URL 9).* For exploratory tasks, animations that accommodate various aspects of interactivity are better placed to offer viewing, query and immediate feedback options. They essentially should allow for the facts to be represented, experimented and analyzed with different combinations of data, map projections and graphic symbols *(Figure 1).* The next section will elaborate on how animation can be applied in the "weather domain".

3 WEATHER DATA PRESENTATION ON THE WWW

3.1 Nature of the weather data

The weather data is partly acquired from geo-stationary and polar orbiting satellites, both of which provide real-time data on various environmental variables. Apart from satellite information, additional data is acquired form ground stations located at strategic positions locally and at a global scale (*figure 2*). The exchange of weather data is absolutely essential, since its is a global phenomena that is highly dynamic. Mediation between national data collection and exchange centers is facilitated through standards set up by World Meteorological Organization *(URL 10).* Note that in compiling the weather map for forecasts and warnings, meteorologist make use of weather surface maps, surface and upper air predictions, measured data, manual charts, and animated satellite and radar images, surface reports and attribute data, all of which can be superimposed over base maps, and/or terrain models.

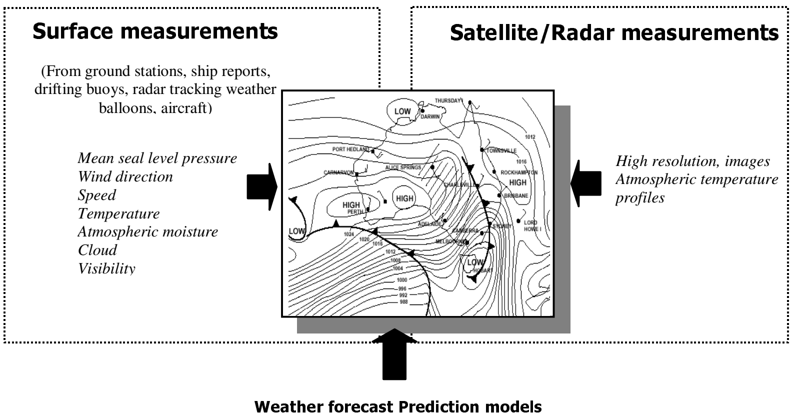

Figure 2. Compiling a weather map using ground and airborne measurements

Since there exists an enormous amount of weather sources and variables, meteorologists can only compile weather maps that meet their target audience *(URL 11).* The weather map can only show some selected aspects of the past, present and future status of the weather, with simplicity but with an emphasis to providing useful information to the intended user. Among such users are aviation industry, field sports enthusiasts, farmers, fishermen, sailors and others.

3.2 Weather data in the WWW

The WWW has emerged as a major medium through which weather enthusiasts can have an almost instantaneous access, on demand, to a much broader range of weather data sets. It is virtually platform-independent, and unrivalled in its capacity to reach many users, faster and at minimal costs. The WWW allows for frequent update of information and viewers can not only have access to current weather data, but also the archived weather data from different sources. Previously, the television, in its narrative nature was able to reach out to a wider audience in explaining weather patterns in scheduled broadcast times. The television stations were responsible for the details and duration of weather maps (Carter, 1993). This is set to improve with the emergence of the digital television technology, in that viewers will be able to view weather data at they own discretion through query search routines. Newspapers have traditionally been the main media for presenting weather information. The static maps come in various forms of color, symbols, supplementing insets with text description, tables with temperature and precipitation data, supplementary photographs, all done with moderation so as not to put off the non-technical reader. Mainly they have served the educative role of not only graphically describing the weather patterns, but also explaining important aspects of the daily forecast.

The WWW complements the television presentation by transferring more responsibility of the creation and visualization of the weather data to the viewer. The viewer, by using varying range of interactive tools, selects and explores weather details at his own time. The diverse range and availability of sources weather data, means that users can explore meteorological data in more elaborate ways than was previously possible. At present, the WWW offers a range of specialized maps, including satellite images, upper air snap shots and a varying range color maps of short to long term weather forecast. The WWW also plays host to a variety of real-time weather variables such as temperature, precipitation values, cloud cover satellite images and Internet tailored movies of hurricanes and storms (Monmonier, 1999). Despite these capabilities, the WWW still lacks the intuition and user-friendliness of enabling users to create, analyze and interpret weather information of their own choice.

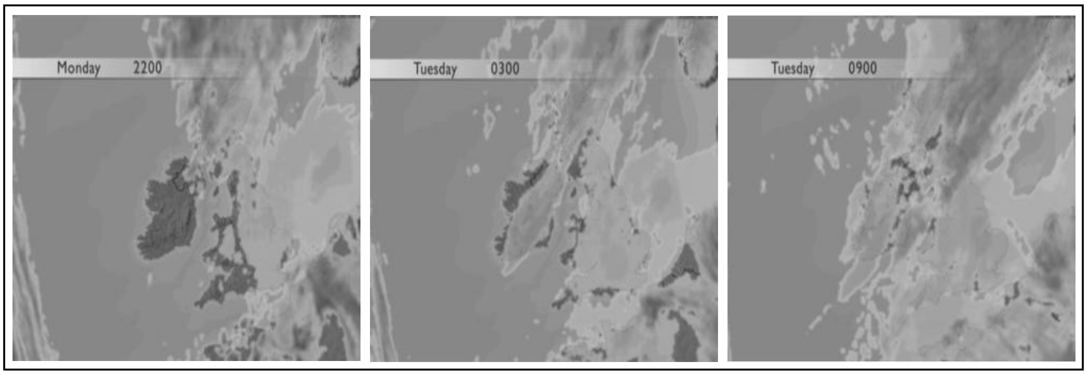

Figure 3. Sequence of satellite images presented at the BBC Web site (*URL 15*). The BBC Website enables viewers to look at the individual images and to play the sequences of the into temporal animation.

Dynamic weather data presentation in the WWW can take the form of: frequent changes in attribute data such as temperature values, wind strength and direction (*URL 12*), sequences of static weather maps (line maps, satellite or radar imageries) that are frequently updated *(figure 3),* a combination of changing attribute values and weather map patterns (*URL 13, URL 14*) or by real time dynamic presentations using animations.

4 ADDING INTERACTIVITY AND DOMAIN KNOWLEDGE TO ANIMATIONS

Our approach seeks to equip both novice and expert users with the specialized ability to visually interpret weather information, thereby facilitating learning and even enable them make reasonable predictions of changes in weather patterns in time. To be able to do this, we provide means for users to delineate and monitor the behavior of the distinct characteristics and the dynamic behavior of various major weather variables.

By delineating the various features of the weather maps and putting them into layers i.e., pressure cells, troughs, ridges etc, users can overcome visual information overloads by selecting appropriate layers of interest and animating them over time. Subsequent layers can be added in temporal synchrony to the already existing animation as need arises, and as the users feel ready to handle more information. Users should be enabled to combine various weather source data, thereby enabling users produce animated maps of their choice and at their own discretion - a change from the pre-designed playback weather animation to user constructed interactive animations. To do this we propose to embed within the animations some domain knowledge in what will we call *intelligent animations*. Intelligent animations will not only lessen the users working memory load, but will also be able to relate features, their influences and effects within the overall system.

With intelligent animations, features within animations are generated on the fly and in synchrony with the other existing features. No longer are viewers confined to one path of view, but loops and branches with new occurrences. This loops and branches will represent the varying user tasks and/or queries that viewers want to pursue. Each graphic element will exist autonomously and controlled by a mathematical expression that describes its size, shape, position, and other attributes in relation to other existing objects. To counter the risks which come more user involvement in the compilation and analysis of weather maps, important domain knowledge embedded within the weather objects ensure that sound weather map construction techniques are adhered to.

Through cognitive modeling, intelligent animations are made to govern what an animated object knows, how the knowledge is acquired, and how it can be used to plan actions (Funge, et al, 1999). These traits enhance its ability to make decisions and respond to user actions during run-time *(figure 4).* This in essence will also determine the systems processing requirements. Real-time responses are computationally involving and thus require computers with a high processing speed. Developers need to determine the optimal means by which changes within the animations are noticed whilst at the same time supporting interactivity, high image rendering ability, user goals and actions. Dynamic query abilities that specifies queries and enables the visualization of their results by accessing the database and providing a real-time feedback to the user's queries will ensure faster, easier, more pleasant and less error prone animation system.

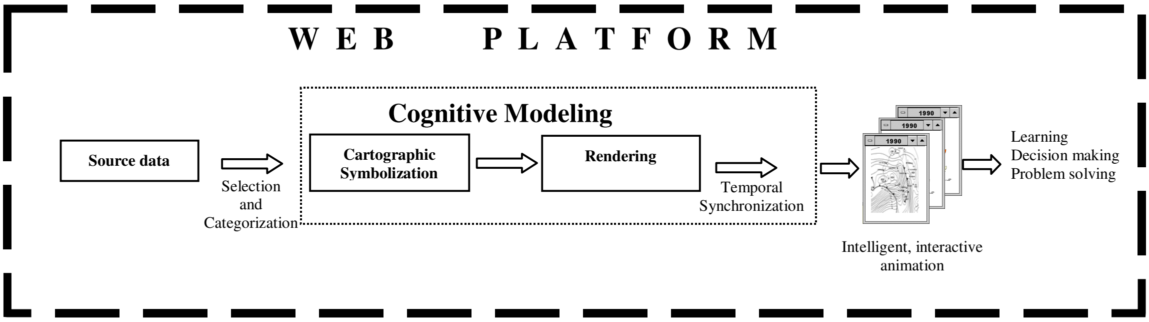

Figure 4. Cognitive modeling for intelligent animations

As applied to the weather map, intelligent animations could be used to characterize typical weather patterns in satellite and radar imageries (figure 5). These patterns can be symbolized tracked as they appear, grow and disappear. Individual weather features can be tracked in isolation from the rest or added as need may be.

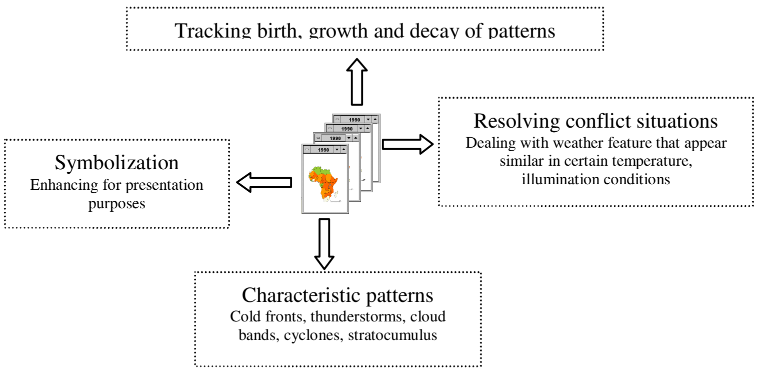

Figure 5. The enabling intelligent animation's ability to interpreting weather information

Embedding the animation with domain knowledge helps to resolve possible conflict situations that might be confusing and difficult to interpret. An example of this type of a situation occurs when features have the same temperature values, then it becomes difficult to differentiate between say, low cloud and either ground, sea or fog. The animations will also facilitate the detection, highlighting and interpretation of the influences and effects of the interactions between weather features. To the technical user engaged in exploratory tasks, the ability of the animation to make decision during run-time has a cognitive advantage in that, it diverts the user's working memory load thereby leaving one to undertake other vital tasks.

5 CONCLUSIONS

In this paper, we have highlighted, how geo-disciplines are capitalizing on the WWW's support interactive and dynamic display to assemble, compile and disseminate maps to users. Within the WWW, and in specific geo-disciplines, the trend that emerges is that dynamic displays are no longer passive and timid which once characterized maps and their use, rather, they are captivating and interactive. Users are more involved in assembling the map components that meet their needs. Additionally, the maps have been imbued with domain knowledge and offer the cognitive advantages that go into alleviating mapping standards within the WWW.

A few hurdles are yet to be overcome; the enormous volumes and nature of the source data might restrict the smooth rendering of some dynamic presentation formats as with animations. Also an area worth studying is the cognitive effect that arise when displays are camouflaged with interactivity, graphic mix, dynamics and domain knowledge and how they influence users tasks in learning, problem solving and decision making.

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URL 2 Virtual campus (VRML)
http://www.ps.ucl.ac.uk/vucl/ucl_campus.wrl (29 mar 2000)
URL 3 Animated shaded maps from Kansas Statistical abstract
http://www.cc.ukans.edu/cwis/units/IPPBR/ksdata/ksah/javamap.htm (29 mar 2000)
URL 4 JavaScript Mouse-over Mapping Example
http://maps.unomaha.edu/AnimArt/ActiveLegend/Peterson.html (29 mar 2000)
URL 5 Animated Maps of Weekly AIDS Mortality in the United States,
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