Developing VR Tools for an Urban Planning Public Participation ICT Curriculum; The PICT Approach

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This paper is a work in progress report on the Planning Inclusion of Clients through e-Training (PICT) Leonardo funded project. The aim of the paper is to present the issues related to the development of appropriate Information Communication Technologies (ICT) material enabling Virtual Reality (VR) technologies in this particular context. The tools developed are organised in three distinct parts: the common core part, the public oriented and the planner oriented. The curriculum structure is analysed, the methods employed in developing the VR tools are presented and the initial experiments are discussed.

Keywords: *Public participation, ICT curriculum, urban planning, VR*

Overview

This paper reports on work in progress as part of the ***Planning Inclusion of Clients through e-Training (PICT)*** Leonardo funded project. The main aim of the project is to enhance active public participation in planning. This paper focuses on the issues related to the development of appropriate Information Communication Technologies (ICT) curriculum material and in particular the Virtual Reality (VR) tools employed. The project addresses all participants in the planning process, the key objectives being to introduce key IT skills, fight technophobia and disbelief, improve communication skills, acquire an understanding of the built environment and spatial representations, and finally introduce game like activities to implement VR support tools.

ICT material development

The learning material developed for the project by the University of Thessaly, is organised in three distinct parts; the ***Core part*** introducing concepts, technology and tools to everybody, the ***Public*** oriented, focusing on communication and visualisation for the public and finally the ***Planners' oriented*** where the emphasis is placed on co-operation and planning design. This structure enables the custom creation of teaching modules for taught courses, or distance-learning courses as designated by the skills of the participants. The reason for including a common core part is that addressing older engineers and planners may not be at all different in terms of IT skills needed, to addressing similarly aged members of the public.

Core tools

The main target is ***achieving basic IT skills*** in operating a computer (components, interfaces, tools), viewing images, documents and printing, fighting technophobia by building confidence on the capabilities to operate computers as well as focusing on practical issues - reasons to use them, potential, benefits, etc. Following, the ***communication skills*** are elaborated in terms of utilising the Internet (searching for information, viewing documents, images, etc and focusing on its potential in creating new communities - both synchronous and asynchronous - online chats, focused discussion groups, fora etc.). Finally, the issue of spatial ***visualization*** is addressed analysing 2D representations (plans, elevations, aerial photographs, video streams), 3D Computer Aided Design (CAD) drawings, perspectives, renderings followed by concepts on synthesizing data from different sources to create a virtual image as well as Geographical Information Systems (GIS). The spatial visualisation introduces the temporal dimension in planning and concludes with Virtual Reality (VR) technologies.

Public tools

As far as the public is concerned an issue that needs addressing is the Greek building regulation (monolithic, strict and absolute, with no flexibility in terms of accommodating particular needs). Initial discussions and past experience led to the need to analyse the building regulations clearly so that public has a reference to what is proposed, what is allowed (plot coverage, maximum height of building, built area allowed, maximum volume of the building, placing the building within the plot - minimum distances to surrounding properties, semi-open vs built spaces, etc) and hence what can be altered. Achieving the above mentioned tasks is a job that must be tackled in co-operation either within the VR model environment or in open discussions with the planners.

Following, the emphasis is in ***understanding information presented***, photomontages, drawings, renderings, video and most important the ability to interact with VR models. These will ***enhance the communication*** with the planners in face to face meetings as well as utilising asynchronous media.

Planner tools

The ***Planner only part*** focuses on ***operating*** the various ICT tools, in terms of building new environments, 3D data formatting, converting, translating information from different platforms, etc. An advanced module will elaborate on interactivity in VR modelling, interfacing with various datasets, etc. Following the piloting of the material, this set of tools could go in depth into the actual design and set-up of 3D urban models. This set of tools needs elaborate testing and evaluation in pilot case studies. It is still not at all clear whether planners will appreciate neither such a tool nor will be willing to learn how to use it. First discussions showed a mixed situation; some are very positive whereas others are against.

Case study

The above mentioned structure will be tested on a few small scale interventions in a particularly poor and problematic neighbourhood of the Agia Varvara municipality in Athens, Greece, focusing on urban regeneration of two squares, refurbishment of street elevations, development of a small park and playground as well as improvement of pedestrian movement and street lighting. The relatively small scale of the interventions generates a series of problems in terms of the low degree of abstraction in geometric modelling acceptable and the high level of realism and extensive use of textures needed to improve navigability, sense of immersion and performance of the users/residents.

Data availability

The original aim was to build an accurate model of the area under investigation. Based on past experience in building the models of the city centre of London and the City of Bath, UK (Bourdakis and Day, 1997, Bourdakis, 1997), it was first attempted to collect all relevant information, city plans, maps, aerial photographs etc.

The case study area has expanded over the last 30 years under minimal control, incorporating areas planned in 1922 for the refuges from Asia Minor and other segments that don't actually have an approved and/or established masterplan. As a result it was not possible to get an up-to-date plan of the case study area and the only one available from the planning office of the municipality is a 15year old paper drawing of debatable accuracy. Such problems are commonplace in newly established boroughs in Greece where funding for infrastructure is minimal and the central government is trying to tackle major problems in a non-structured and methodical manner.

To make matters worse, the case study area has an estimated 10% of buildings built over the last 15 years without counting the ones that have had extensions and considerable modifications altering substantially the overall image of the buildings, streets, etc. Consequently, the available plan cannot be the starting point for the model building. The interventions planned (regeneration of two squares, improvement of pedestrian movement, etc) have being initially tendered to engineering firms that submitted survey plans of the areas involved together with their proposals. It was therefore decided to base the modelling on the individual contractor drawings. The inaccurate old plan was used for building the low polygon count volumes of the urban blocks surrounding the areas under examination - the resulting geometry is only visible from birds eye views of the area where judging distances and generally analogies and sizes is of relatively low importance.

The available drawings in (AutoDESK AutoCAD format) submitted incorporate 2D information on area layout, street furniture and building footprints. The only height information is spot heights relating to street/pavement levels. Aerial photographs at a scale of 1:10000 and 1:2000 are the only other source of information available albeit dating back to 2001. The morphology of the cityscape of the area featuring narrow streets (6-8m wide), 3-4 storey buildings covering typically 70% of each plot leaves little for aerial photogrammetry to aid in model building.

The data collected

Examining the data gathered as mentioned above it was made clear that two discreet sets of data are missing: the building height and facade geometry of each building. Having ruled out the use of stereo pairs of aerial photographs (time and cost constraints – such a task was neither within the budget nor the timescale of the project) it was decided to resort to land photogrametric data for the model building. Such an approach has the advantage of a single stage data collection that during the research lab processing stage produces the two types of data missing from the urban model. The tool most suited for the job was Photomodeler Pro, by EOS Systems Inc. A digital photographic camera (Nikon Coolpix 880, 3.2Mpixel) with a .66X wide-angle converter was fully calibrated and used on all photographic surveying. Projects per urban block were set-up enabling the process of up to 15 photos per block and resulting in textured 3D models of the relevant areas.

The model construction

The Photomodeler Pro output, in AutoDESK 3Dstudio format or ready textured VRML97 is the starting point for the production of the VR interactive environment. Unfortunately, the accuracy of all photogrammetric programs and even more so the (relatively) low cost and performance ones is far from perfect. The main concern is that there is no way that the engineering survey plan information supplied by the engineers producing the proposals for the regeneration areas can be parsed into the model processing mode. Every attempt at post-editing the Photomodeler 3D model in AutoCAD or Discreet 3DSMAX proved pointless, extremely time-consuming and inaccurate. Furthermore, importing any Photomodeler dataset into AutoCAD removed all texturing information. Photomodeler's constraints regarding the verticality of walls, horizontality of window and door sills, balconies, etc is a useful tool but in practice proved unable to correct all discrepancies of the collected and processed data. As a result, when the whole façade misses the survey plan data by 15cm or even worse the wall intersections in plan are not in right angles then there is not much that can be corrected in a 3D modelling environment.

Completing all possible experimentation and combination of data sources and processing methods, it was finally decided to spend less time in solving all possible combinations of façade elements in Photomodeler, and use the resulting data as:

- Elevation data
- Balconies projections in plan and elevation for the lowest balcony
- Orthophotography production tool (again with a few limitations) correcting texture maps for building façades.

So the final procedure is organised in the following steps:

1. Collect photographs of buildings, using different angles both in plan and (if possible) in elevation
2. Process them via Photomodeler
3. Select and calculate heights of building facades as well as geometry and heights of lowest balconies for each individual building
4. Produce orthophotographic textures on the elevations of all buildings.
5. Touch-up the texture photos in an image editing program in order to remove passing people, occluding trees, street furniture, cars, etc
6. In a CAD package (in this particular case, AutoCAD) start from the engineering survey data and build a 3D model using the Photomodeler processed data.
7. In a 3D rendering package (in this case 3Dstudio Max), add textures and detailing to the model.
8. Export it to a VR environment. This can be either VRML97 based, viewable via freeware plug-ins available for all common Internet browsers or via standalone VR applications such as Sense8 WorldUp or OpenSceneGraph.

Due to the already described particularities of the area under investigation and the interventions proposed, the focus of the VR presentation tool is within close proximity of the visitor's eyes: the pavement and ground he/she is moving, the facades of the buildings and especially the ground floor walls, shop-windows, etc, the street furniture, the trees planted on the pavements and finally the geometry (size and elevation) of the first (lowest) balcony of each property.

Care must be taken in separating the landscaping, pavements, street furniture, trees, etc of each regeneration area so that alternatives can be loaded and unloaded in the resulting VR model at will.

A great concern in building such 3D urban models is the size of the resulting geometry, the spatial organisation in Levels of Detail (facilitating navigation and rendering speed) and the number and size of textures necessary. Special compression tools were used in order to reduce the size of the geometry, although typically geometry data are only 3-6% of the overall data communicated the rest being façade images.

The VR tool implemented

A draft version for the regeneration of Makrygianni Square was demonstrated at the 4th Transnational PICT meeting in Athens (May 2004). Operating systems supported are Microsoft Windows and Apple Macintoshes. The VR tool demonstrated is in the Virtual Reality Mark-up Language (VRML), the standard for communicating and visualizing 3D data on the web for almost a decade since its conception in 1995. This makes overall compatibility, flexibility and accessibility an easy and effective task. This is particularly important since the player needed for experiencing such VRML files is readily available as a 1.4MB download from a suggested web site meaning that anyone from any computer (home, office, internet café, etc) can have immediate access to the VR model.

The non-geometric representations for street furniture and mainly trees caused certain small scale problems regarding the overall impression a visitor gets on the volume, foliage and subsequently shadow expected on parts of the redeveloped area. However, the lighting model of VR applications in general and VRML in specific is quite problematic as far as outdoors lighting variations is concerned since there is no support for shadow casting, direct lighting, volumetric lighting, etc.

The environment features a single-user set-up; each user enters the virtual space on his/her own, can organise his/her experiencing the place, spend as much time as he/she feels necessary to comprehend the layout and give feed-back to the designers.

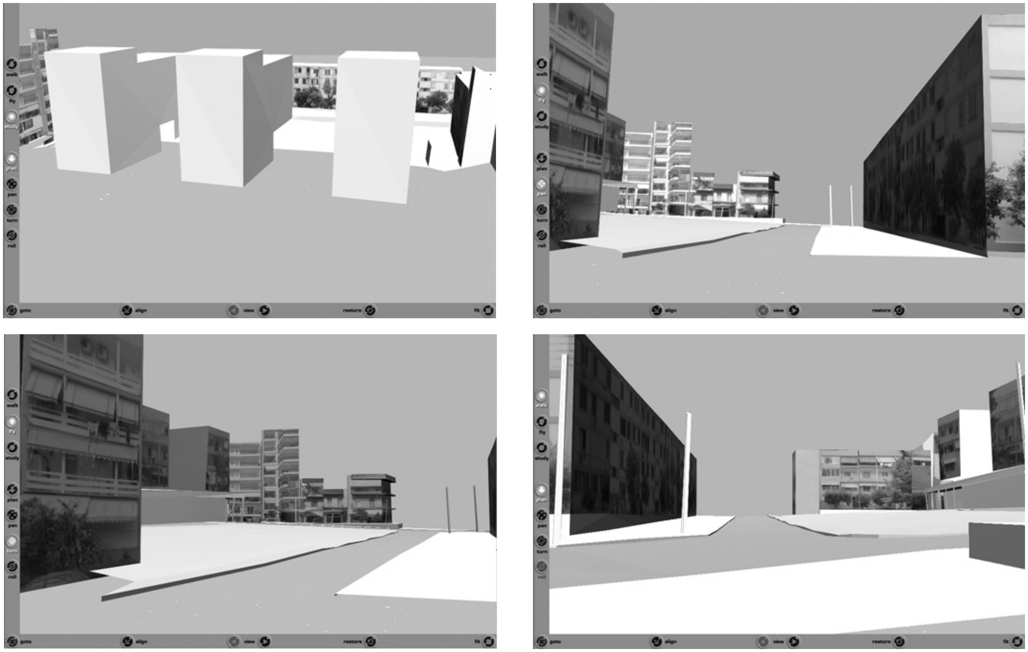
Interaction modes for the 2 user groups [public and planners]

Apart for navigating and exploring the environment, the feedback mechanism devised is worth analysing into more detail. The user has a commenting tool that he/she can use to place comments in the exact spatial location that he/she considers as appropriate. Such an experiment was first carried out during the Ijburg development project in the Netherlands in 1997 (see Bourdakis 1997). Comments are colour-coded Red for negative and Green for positive. Comments are visualised via spheres floating within the environment. The comments are either in audio format (visitors in a high bandwidth access point featuring high performance computers installed with the appropriate real-time audio encoding software - comment duration up to 2 minutes) or textual (visitors in a low bandwidth access point) and are linked to the appropriately coloured sphere. The important fact is that all such spheres are visible and accessible to new visitors, so the build-up of knowledge and practice is retained, passed on to the next visitor and he/she can comment not only on the merits of the proposal but also on the previously placed comments. It is also a very interesting visual feedback to the designers as well as the following visitors as a birds eye view of the area shows the differently coloured spheres segregated on the problematic or satisfactory areas of the model respectively. The number of such comment spheres visible is still under consideration, since too many comments are inhibiting visitors in commenting themselves.

An issue that is always of great concern in VR environments is navigation and way finding. A well known and elaborately tested solution often employed in the gaming industry is a semi-translucent 2D map of the area on a heads-up display (HUD) following the user as he/she moves about the VR model. Initial experiments with the residents showed that in this particular setup the amount of detail available at street level is sufficient to orient and familiarize the residents that added to their low level of education and familiarity with map reading renders the abovementioned technique inappropriate.

The planners' specific tools

The VR tool proposed for the planners' interaction with the available data, is identical to the public one described above with few exceptions. The most important is the addition of a 2D map on a HUD as planners' familiarity with the area is at a very different level to that of the residents'. Furthermore, this 2D map may incorporate other information useful to the planners (i.e. colour coded building regulation data for the area). The other option available to the planners is the ability to visualize the city as if the regulations allowance for building heights was fully exhausted. This is done in a semi-translucent grey block model, generated automatically based on the regulations permissions for each urban block, super-imposed on the existing city model. Employing a birds eye view, this tool clearly designates structures not in line with the current legislation (protruding from the translucent grey blocks) as well as areas where building activity is potentially expected (empty grey block areas).



Building the VR model, maintaining the 3D datasets and underlying databases, texturing, managing collected data in terms of public participation sessions, etc are issues not dealt directly by the planners as it is strongly believed that the research team responsible for the creation of the model should be in charge of such processes. Once the prototyping stages are completed, it may be possible to automate certain parts of the process and let planners manage certain data subassemblies. However this will depend on the conclusions drawn on the PICT project experiences, the attitude of the planners as well as their IT skills.

Conclusion

The VR tool produced for the PICT research project is sufficiently accurate, relatively efficient in time spent developing hence cheap to produce and update and provides a high density of visual information to the viewer/visitor. The ability of each user to interact with the model, switch between alternatives (existing and proposed) and most importantly add comments (textual or aural) to particular points within the model is enhancing communication creating a pseudo-multi-user environment without the extra complexity, resources and problems involved (data security, high-bandwidth, specialised software and hardware, etc). The proposals and comments are summed up and presented to the experts who will/should act accordingly, decide what can and should be satisfied and feed back to the designers and the public.

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