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A Framework for the Development of Online, Location-Specific, Expressive 3D Social Worlds

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Abstract— Today social networking sites are emerging as increasingly popular communication spaces where one can see and talk to friends and acquaintances. However, these sites require different methods of offering the additional information that are often useful or essential in human interaction such as, the conveyance of emotion or a realistic representation of one's geographical or urban location. Our research concentrates on addressing these issues by offering fully expressive Internet communication with the use of 3D expressive models to help provide some of the visual cues that are present in face-to-face interaction. This is achieved via an innovative piece of software called Emotion Analyser that analyses text messages in the Internet communication environment. Moreover, a dedicated 3D facial animation system has been generated that interfaces with the Emotion Analyser in order to translate its output. Finally, the 3D virtual city models for the final interactive virtual world have been produced by using our own semi-automatic urban modeling system called Virtual City Maker.

Keywords—virtual worlds, social interaction, emotion extration, urban modelling, facial animation

I. TRANSLATING EMOTION FROM TEXT

Due to the nature of the medium, social interaction within the virtual world does not provide online participants with the same experience of a face to face meeting. Important aspects that are absent include the visual cues of emotion that are provided by facial expressions [1], and a realistic representation of one's geographical or urban location. We propose a framework that combines three systems that would enhance social interaction within virtual worlds (figure 1a); the Virtual City Maker [2] to create realistic geo-referenced 3D environments, the Emotion Analyser [3] to automatically identify emotions in text messages passed between participants, and a 3D facial animation system to dynamically display appropriate facial expressions.

The Emotion Analyser (figure 1b) is a rule-based word tagging system that uses an emotion extraction engine to identify explicit emotional keyword and phrases. The engine receives text from the interface layer. The input analysis component divides the text into individual sentences and passes them to the tagging system. The tagging system splits the sentence into individual words and phases, and searches through the tagged dictionary of over 17,000 words and replaces all emotional words with the appropriate tag. All emotional words are classified into one of Ekman's six

universal expression categories: happy, sad, surprise, fear, anger, and disgust [4]. Three different emotion intensities are defined for each expression category.

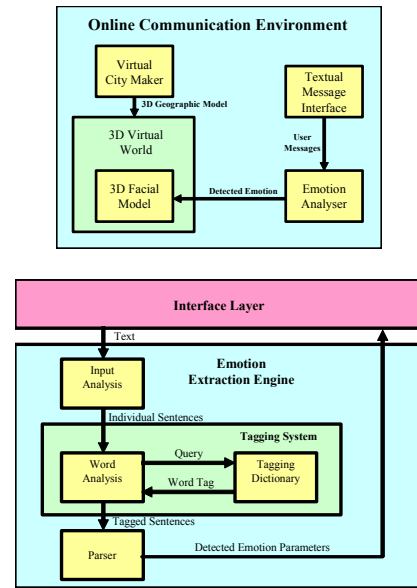


Figure 1. a. Proposed architecture b. Components of the Emotion Analyser

The parser examines the tagged sentence to establish the emotional state of the sentence. A set of rules are followed to identify which emotional words are present, the person to whom the emotional words referred and the intensity of the emotional words. The parser also checks whether there is a condition attached to the emotion e.g. 'I'm happy when she's there!' is interpreted as an emotional sentence, but with reduced intensity. When exclamation marks are found, the intensity of the corresponding emotion is increased. If an emotion word is found in negative form, the parser will not treat the sentence as containing an emotional word, the negation of one emotion does not automatically indicate the presence of the opposite emotion. The parser also resolves situations where conflicting emotions are found in the same sentence. Decisions are made based on the momentum of emotion as indicated by the average weighted emotional mood indicator. It is assumed that the mood of the last sentence should carry more weight to the representation of the user, therefore greater weight is given to the emotions contained in the most recent sentence with progressively less weight to earlier sentences.

II. DEVELOPING AN URBAN-AWARE 3D VIRTUAL CITY ENVIRONMENT

Although comprehensive procedural virtual city-generation software exists today such as the one presented by Mueller et al. [5], producing 3D urban content in an accurate and georeferenced manner which can also be integrated in a larger framework like the one presented in this paper remains an issue. To address this we propose the Virtual City Maker modelling tool, a system comprising of *two modes*; the *automatic* and *semi-automatic*.

First of all, regarding the input data used the authors of this paper have selected a combination of aerial photographs and also 2D ground maps, at least for the outline of the buildings modelled. This more hybrid approach combines the strengths of two different techniques for a more efficient result. Aerial images ensure accurate results and the bypassing (to a certain extent) of a generalization process while ground maps provide positional and geographic information. Delivering accurate location information in 3D is crucial to location-aware social interaction. Therefore, geo-referenced results and accuracy are key issues with errors in geometry placement only afforded to be marginal making this hybrid data use approach even more justified. Having placed building footprint outlines in a precise manner, these outlines have been extruded to real world heights using, if needed, GIS vector data in the form of the .shp file format. This particular file format operates as a combination of CAD data with added metadata attributes. Using this particular data is a key part of our system since it can not only compliment the aerial image information but also solve many inconsistencies and thus produce output of far greater quality compared to other systems since not only does it provide structure outlines for individual buildings but other 2.5D information such as different heights, shape values, age values, type information and even land use.

There are cases where end-users/software developers for social virtual worlds would require more customizable urban content than that generated by their postcode location and real-world maps, i.e. urban content for their placement which is not derived from GIS coordinates but can be fictitious. The semi-automatic mode of the application presented here can cater for that via individual plug-ins. Interfaces for Virtual City Maker can be either stand-alone as individual plug-ins or unified. The creation of 3D buildings can either be imported from CAD files such as 2D ground plans or can be freeform ones that the user can draw. Multiple floor segmentation for the building is offered as well as roof modeling with controllable height and overhang based on the user's selection (out of a range of roof shapes), the ability to create insets for additional geometric detail and also allowance for texturing. This final process has been implemented by means of assigning different numerical material IDs to each floor and roof so that when the user selects an image to map onto a surface it will be saved according to this ID selection. This speeds up and simplifies the otherwise tedious process of texturing while at the same time giving the user full control on it.

Recent research suggests that other ways of rendering (beside the photorealistic one) 3D urban content can also be beneficial for communicating elements of numerous other

principles such as cognition, cartography and non-photorealism which could potentially offer benefits to expressive communication. Thus an additional plug-in has been incorporated to the Virtual City Maker solution called City Shader in order to explore these possibilities. This facilitates the production of more complex non-photorealistic (NPR) styles resembling more abstract human 2D artwork such as cel-shading, hatching, line rendering and watercolor rendering (figure 2). Most importantly, these different types of shading can be exported to suitable file formats for real-time use which involves a number of issues considering real-time virtual worlds are not ideal to handle expressive urban-area visualizations.

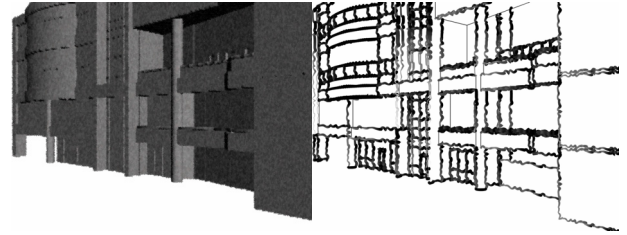


Figure 2. Various views of urban models using the City Shader

The algorithm used for one of the results above (and for various other cel-shading visuals in our system) is a variant of the one presented by Lake [6] which rather than smoothly interpolating shading across a model as in Gouraud shading (another popular approach), finds a transition boundary and shades each side of the boundary with a solid color.

Work is currently underway for an automated facial animation system to be integrated with the Emotion Analyser and Virtual City Maker applications described above. This system is developed using Discreet's 3D Studio Max scripting language called MaxScript. The purpose of the system is to both interface with these two applications in order to extend the emotional facial animation seen already from 2D to 3D, and also offer us with a system that would severely cut down on the number of hours spent on the tedious manual task of lip-synching.

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