Assessmentville - A Preview

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Abstract

The Cognitive Map Probe (CMP) is a novel TUI-based automatic cognitive assessment tool attempting to measure the cognitive mapping abilities of its users. The CMP uses a TUI-based environment we call Assessmentville in order to support natural acquisition and straightforward assessment of cognitive maps. The CMP assesses early Alzheimer Disease (AD) by measuring the decline in cognitive mapping abilities, a decline associated with early phases of AD. Assessmentville enables the user to interact with a virtual neighborhood environment by manipulating highly realistic, highly detailed, physical 3D models. Assessmentville subparts were designed as realistic 3D small-scale models of physical landmarks and later printed using a 3D printer. We are currently using a computer-game (Half-Life®) graphical engine for the virtual interaction with Assessmentville. We believe that the CMP's usage of identical physical and virtual entities affords a very simple mapping between the virtual and physical elements of the interface, making it very valuable for elderly users.

1. TUIs and Reviving the Segal Model

Tangible user interfaces can be defined as: *interface devices that use physical objects as means of inputting shape, space and structure into the virtual domain*. Several research groups have been active in the field over the last 20 years (see [16]). The Segal model was built by Frazer and his group to enable users to interact with a floor plan both tangibly and virtually [7]. The model is a large board with an array of edge connector slots enabling the connection of numerous objects (each carrying a unique diode-based code) while tracing their location and identification in real-time. Recently, the Segal model was modernized so it can connect to a PC through a standard parallel port, using a Linux driver to scan the board and a Half-life® computer-game-engine to perform the rendering [15].

2. TUIs for AD Assessment

The use of tangible, physical objects as a means of supporting neuropsychological assessment is well established. Constructional functions, i.e. perceptual activity that has motor response and a spatial component can be assessed by visuoconstructive tasks that involve assembling, building and drawing [9]. Computer-assisted psychological assessment is growing rapidly and most major psychological paper-based tests are expected to be automated in the near future or have already been automated [7]. Generally, the advantages of automating a psychological test are the saving in professional's time, eliminating tester bias and potentially improving test reliability [7]. Computerizing a test can also capture response latency, enable questions to be tailored according to the examinee's past answers [7] and enable capture and use of variables that otherwise would require close attention of a professional.

Assessment of AD in its preliminary phases is extremely important since these phases of the disease have major implications on the person's ability to perform everyday activities that were previously well within her capabilities, like driving or finding her whereabouts in a new place [10,11]. Currently AD assessment is performed by neurologists, geriatricians and occupational therapists. We believe that computerized, TUI based AD assessment can provide insight into numerous assessment parameters that are hard to sample or completely inaccessible to the human professional. We also believe that eventually such tools might prove to be reliable to such extent that early AD assessment could be unified into a single test, automated and administrated by non-professional caregivers.

3. Cognitive Maps and Early AD

Cognitive Maps are: *an overall mental image or representation of the space and layout of a setting*. Cognitive mapping can be defined as: *the mental structuring process leading to the creation of a cognitive map* [1]. The most widely accepted model for cognitive mapping is the Landmark-Route-Survey (LRS) model [3,6]. The highest level of cognitive mapping ability - survey knowledge - is the ability to integrate landmark and route knowledge of an environment into a detailed geometrical representation in a fixed and relatively precise global coordinate system (e.g. the ability to draw a detailed map).

Although different manners of interaction with an environment will lead to different levels of knowledge and might result in different cognitive maps [1], both physical and virtual environments are valid means of acquiring cognitive maps as both are external to the learner [6].

Cognitive maps can be probed using several techniques, e.g. verbal, bearing and distance, map-based and functional techniques [4,8]. Related to our effort is the map placement technique in which the user is asked to point to an object position on a grid, or to place an object representation tangibly [2,8,12]. Very few attempts have been made to semi-automate the probing of cognitive maps. Baird et al. [2] displayed a 13x13 grid for computerized map placement. Later, direct computerized bearing input was implemented in various efforts [3,13].

Assessment of the high-levels of cognitive mapping abilities, i.e. survey knowledge, is expected to achieve high discrimination between early AD patients and healthy elderly persons [11].

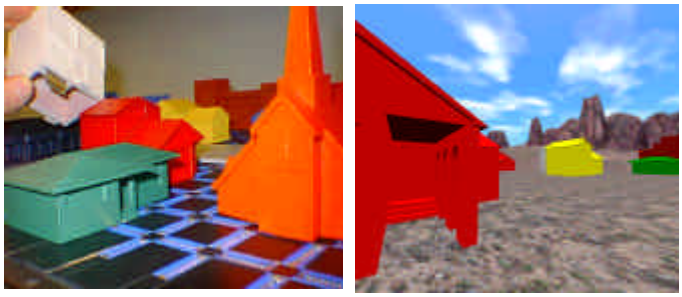

Figure 1. CMP - physical (left) and virtual (right) overviews.

4. Assessmentville

The CMP [14] is designed to enable automatic assessment of early AD by attempting to probe the more advanced cognitive mapping abilities, (survey knowledge). The CMP consists of Assessmentville (an adaptation of the Segal model) as the input device and a large display screen for output. The CMP assessment process begins by familiarizing the subject with a new environment, resembling a typical neighborhood, by enabling exploration of a virtual representation of the environment. The CMP then queries the subject's cognitive map by asking her to reconstruct the virtual environment, or parts of it, using realistic small-scale models of the environment's landmarks as interfaces, plugging them into the Assessmentville grid (please see figure 1).

The tangible interaction is supported by a set of realistic small-scale models of unique landmarks, such as residential houses, a church, a grocery store, gasoline station and a fire department. All the models were designed in high detail using 3D-CAD tools and later printed at a consistent scale using a 3D printer. A unique diode ID was manually inserted to a socket printed in each model. While the user manipulates the small-scale physical models and place them on top of Assessmentville, the CMP detects each model's ID and location and renders the model's virtual counterpart accordingly. A computer game (Half-Life®) graphical engine is used for the real time interaction with the detailed 3D virtual models.

While the CMP hardware is mostly done, the work on the assessment software is ongoing and preliminary user evaluations are expected by mid 2001.

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