OVERVIEW OF ACTIVITIES 2007 – 2010

Looking at the future of games

Game research for training and entertainment

Game research for training

The GATE project is funded by the Dutch government through ICTRegie. ICTRegie is a compact, independent organisation consisting of a Supervisory Board, an Advisory Council, a director and a bureau. The Minister of Economic Affairs, and the Minister of Education, Culture and Science bear the political responsibility for ICTRegie. The organisation is supported by the Netherlands Organisation for Scientific Research (NWO) and SenterNovem.

and entertainment

INTRODUCTION

The GATE project involves game research, innovative pilots, and knowledge transfer to industry.

To advance the state-of-the-art in gaming and to facilitate knowledge transfer to companies, the Dutch government has funded the GATE project with a total budget of 19 million Euros. The project runs from 2007 till 2012 and involves seven partners: Utrecht University, Utrecht School of the Arts, TNO, Twente University, Delft University of Technology, Waag Society, and Thales.

It is always difficult to predict the future. But it is clear that the possibilities of gaming will rapidly increase over the coming years. New graphics cards allow for increased visual realism but this must be accompanied by increased behavioral realism of game characters. New interface technology will enable a different, more natural form of communication and control. Gesture recognition, tactile feedback, and direct brain connections will become possible. And new insight in learning processes in virtual worlds will improve the effectiveness of serious games.

The ambition of the GATE project is to develop an international competitive knowledge base with respect to game technology, and to train the talent required to enhance the productivity and competitive edge of small and medium-sized creative companies. The project assists companies producing (tools for) games and simulations by providing direct access to new technology. The project makes people aware of the possibilities of gaming in public sectors such as education, health, and safety by performing pilots in these areas.

Research program

The GATE research program has four themes. Modeling the Virtual World focuses on techniques for semi-automatically creating convincing and engaging virtual worlds that can be used in games, reducing the production cost. Virtual Characters deals with the creation of realistic behavior for the virtual characters that inhabit the games, to increase the immersion of players in the game world. Interacting with the World studies novel interaction techniques that improve the way users can control their games, using for example gesture recognition and brain-machine interfaces. In Learning with Simulated Worlds we study how games and virtual worlds can best be used for training and education, to improve the quality and effectiveness of such serious games in the future.

Knowledge Transfer Projects

GATE is not only about academic research into games and game-technology. GATE is also geared towards developing this knowledge further into practical solutions through knowledge transfer projects in which small and medium size enterprises collaborate with research partners. Companies provide knowledge questions and intended applications. The research partners provide new technology. The projects combine these into practical solutions that make the research results fit-for-use for industry. Close to fifteen projects are envisioned, half of which are already underway.

Innovative Pilots

Within GATE a number of innovative pilot projects are carried out, to create awareness of the potential of gaming and simulation in the sectors education, healthcare, and safety. In developing these prototypes we have established collaboration between game designers, creative artists, educational specialists, ICT experts, and domain experts. For example, we developed prototypes for a game for physics education, for non-verbal communications between patients and relatives, and for training mayors to deal with disasters.

Results

In this magazine we present you the results obtained during the first three years of the project and the plans for the future. If you are interested in learning more about the different projects, feel free to contact the project leaders or the GATE management.

Steering Committee
The GATE steering committee takes all major decisions in the GATE project. It consists of:

» Erik Jansen
Delft University of Technology
» Frank Kresin
Waag Society
» Jeroen van Mastrigt
Utrecht School of the Arts
» Anton Nijholt
Twente University
» Mark Overmars
Utrecht University
» Aart-Jan Smits
Thales
» Peter Werkhoven
TNO

Advisory Board
The GATE advisory board monitors the progress of the project and advises the management team about desired changes and opportunities. It consists of:

» Michael Bas
RANJ
» Arjan Brussee
Guerrilla Games
» Frank van Oirschot
Dutch Games Association
» Gerard van Oortmerssen
ICTRegie
» Martin de Ronde
One Big Game
» Pjotr van Schothorst
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Management Team
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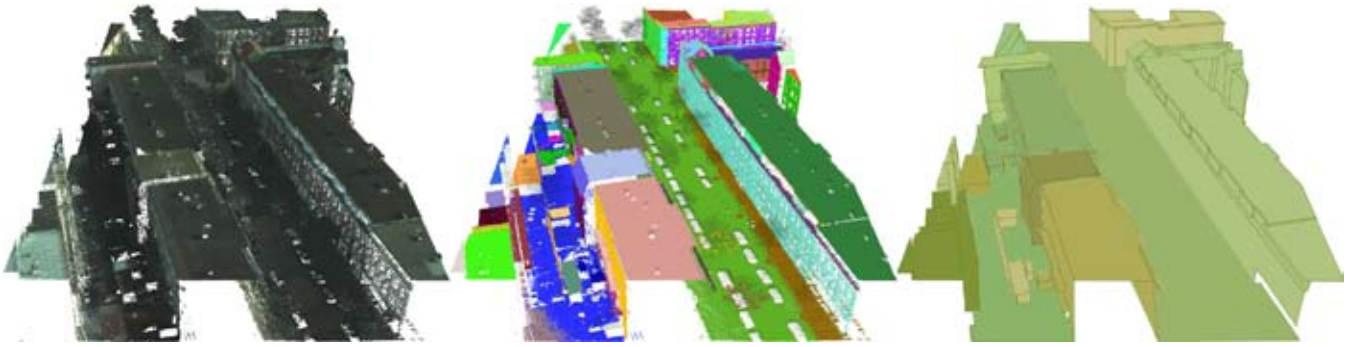
Reconstructing cities in the real world



Modeling the Virtual World

Automating reconstruction to quickly create virtual copies of real cities.

Workpackage
1.1 Automatic World Generation Based on Real Data

Partners
Utrecht University
TNO Defense, Security and Safety

Budget
500.000 euro

Key Publication
Van Kreveld et al. (2009). Identifying well-covered minimal bounding rectangles in 2D point data. Proc. 25th European Workshop on Computational Geometry, pp. 277-280

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Emergency services, municipalities, and location games require a detailed and up-to-date virtual copy of a real-world urban scene. Automating reconstruction can greatly reduce the time and cost of the process. New methods have been developed that can efficiently perform steps in recreating the world. Soon the whole world will be completely modeled in 3D.

To create a geometric 3D model of the real world, we need to reconstruct the scene from data sources such as images and laser range. The detail and complexity of the reconstructed model depend on the amount and quality of the data, while the time needed for reconstruction depends on the efficiency of the methods, especially when using larger data sets. This project is aimed at automatically reconstructing geometric models from laser range scans of large real-world urban scenes. These scans result in large clouds of points in 3D space. The methods should efficiently reconstruct a detailed and precise representation of the real scene from these points.

Bounding rectangular surfaces

The reconstruction process can be split into different parts like identifying existing infinite surfaces that pass through many points, bounding the points in these surfaces, and filling the remaining gaps where data is missing. Urban scenes contain many simple surfaces, and for the typical scene about a quarter of the surfaces are rectangular. We developed a new method for efficiently bounding the appropriate surfaces using rectangles. After different surfaces are identified in the data, each surface is checked to see if it should be bounded by a rectangle. We have developed a method to determine whether the data in a surface is well covered, such that there are no large parts in the rectangle that are void of points. The Netherlands Forensic Institute (NFI) has provided a laser range data set, and our method efficiently identifies surfaces in this data set and provides the rectangles that correctly bound each surface. Once rectangular surfaces are identified and bounded, the remaining part of the scene may be searched for increasingly more complex shapes. Alternatively, the shapes bounding the surfaces may be based on the data distribution instead of predefined forms.

Data-driven boundaries and stitching

Surfaces may be bounded using predefined shapes like rectangles, triangles, L-shapes, etc. or their boundary shape may be determined from the local data distribution. We are currently developing a method for data-driven boundary creation. This method not only takes into account the data measured in one surface, but also the shapes of neighboring surfaces. The method should result in a shape that is easy to connect to neighboring surfaces, while behaving nicely in the presence of noise and missing data.

"Soon the whole world will be modeled in 3D"

Because of measurement problems like low data resolution and occlusion, some parts of the real-world scene may not be captured in the data. Stitching together the bounded surfaces that are present in the data may reveal these holes in the data. We will develop techniques that can identify missing parts in the data and fill these parts in a realistic way.

From pictures to 3-D

Modeling the Virtual World

Building virtual models of the world using pictures.

Virtual models of the real world are typically built by a specialized team of designers and developers. Consequently, this costs a lot of time, effort and money. Now, imagine being able to do away with this by just going outside, taking some pictures of the desired scene, uploading them to a computer and pressing a key.

Virtual models of real world scenes are commonly required for simulations, entertainment purposes, navigation and many others. Instead of having to model these by hand, many researchers are exploring ways to do this automatically from a variety of data sources like imagery and laser measurements. Our objective is to be able to exploit the vast amount of real world imagery that is available, like the panoramic images that are acquired in large volumes, or the many image databases that are on the internet, and create complete 3D models from that data.

"Virtual representations of existing environments can be automatically built from images"

Humans are smart, computers are not?

Estimating the 3D structure of what we see around us is something our eyes and brain do so easily that we don't even realize it. For a computer, working from captured images this is a lot harder. The problems start with finding corresponding points between the images. Research has turned out that even the most state-of-the-art methods are often not able to find out which parts of two images are the same when the images of a scene are taken from quite different perspectives, yet this is a key requirement in order to be able to calculate depth. Our research has analyzed the points of failure for commonly used point matching techniques. Based on these finding we try to propose improved matching algorithms that are effectively computing corresponding points between images, even when the images are taken from quite different perspectives. The matched points then are easily converted into 3D points that describe the scene.

You have a point there, but now what?

Developing new methods to calculate the 3-dimensional position of points in the scene is but the first step. A set of points is not yet a model that describes surfaces, joined together at the edges to form a closed whole. Many existing algorithms try to find these surfaces from the 3-D points only. In our research we plan to combine the points that were found with additional information contained in the images. By virtually slicing the images apart into segments along the edges of components in the scene, we identify the surfaces which are needed in the model. Exploiting the principle that '3 points define a plane', by combining the segments with the position of the points, it is possible to calculate where the surfaces of the objects are in the real world. Combining these surfaces then provides the virtual model of the real world environment, exactly what is so desired.

Workpackage
1.1 Automatic World Generation Based on Real Data

Partners
TNO Defence, Security and Safety
Utrecht University

Budget
400.000 euro

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Sensibly stuffing game worlds

MODELING THE VIRTUAL WORLD

New techniques to orderly populate virtual worlds with smart objects.

Workpackage
1.2 Automatic creation of imaginary worlds

Partners
Delft University of Technology

Budget
500.000 euro

Key Publications
T. Tutenel et al. (2008). The role of semantics in games and simulations. ACM Computers in Entertainment 6(4):a57
T. Tutenel et al. (2009). Rule-based layout solving and its application to procedural interior generation. Proc. CASA workshop on 3D advanced media in gaming and simulation, pp. 15-24.
T. Tutenel et al. (2009). Using semantics to improve the design of game worlds. Proc. 5th conference on artificial intelligence and interactive digital entertainment, pp. 100-105.

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In huge urban game worlds most buildings are inaccessible since manually designing all their interiors is simply unaffordable. Enriching objects with real-world logic and mutual relationships can open up more interactive, convincing and immersive interiors. We developed semantic layout solving techniques that facilitate the automatic generation of such lively environments.

Objects in virtual worlds are mostly related to other objects in their surroundings. A desk without a chair or a computer without a keyboard appear weird, so in a working office we see these items placed together, following some logical rules. This project investigates ways to enrich virtual objects with information about their functionality and relationships to other objects, in order to automatically find suitable locations for them in a sensible context. We developed a layout solving approach that uses these semantically-rich objects to procedurally generate and populate realistic layouts for virtual environments, e.g. building interiors, gardens or city streets.

Semantic layout solving

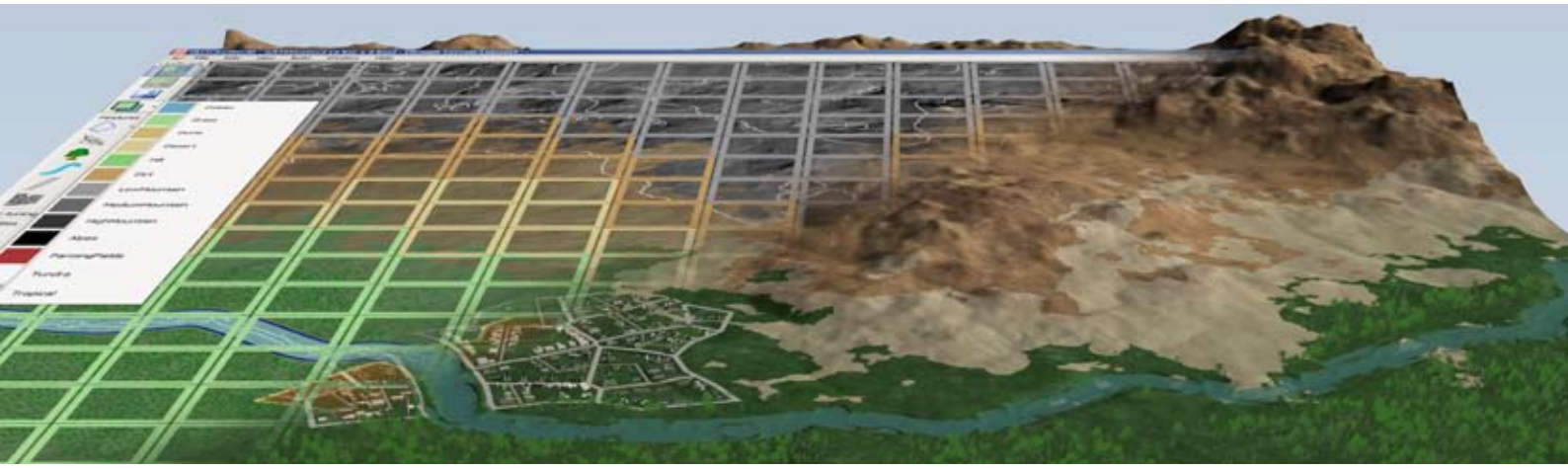
We developed a semantic library with many classes of objects, each describing their type, functions, services, possible relationships to other objects, and also how players or AI characters can interact with them. For instance, you can define specific clearance areas around an object, e.g. to make sure there is enough space in front of a cupboard to open it. Using this information, our semantic layout solver takes a description of all objects desired in a given scene and incrementally determines sensible locations for each of them, in order to create a complete and meaningful layout.
To specify the contents of generic scene types, e.g. a kitchen, a living room or an office, we defined an intuitive description language, mainly focussing on the object types that can or should be present in such scene, as well as on possible, scene-specific relationships and qualifiers. Based on these descriptions, every instance of these scene types can be laid out using the semantic layout solver.
Eventually, every scene instance can also be automatically refurbished or decorated using semantic filters, typically linked to some predicate from the semantic library (e.g. dirty, antique or messy), further customizing its visual details without altering its specific intent.

Rapid game prototyping

Using the above descriptions and layout solver, level designers can quickly create virtual worlds. Since all its objects include functional information, sensible object interaction is at once embedded into these virtual worlds, making them ideal as exemplar worlds for rapid prototyping. We are investigating integrated methods to specify both semantic descriptions for game worlds and gameplay-related object interaction in order to test gameplay aspects much before level designers finished the entire world. Eventually, these prototype worlds have to be manually refined by designers. We are currently investigating how to guarantee that all sensible relationships set among objects are kept in that process. For this, in close cooperation with the other Workpackage 1.2 project (see next page), we are developing semantics-based techniques for maintaining world consistency after each manual operation. Together, such techniques can allow designers to create game worlds quickly and efficiently without losing control over the final product.

> *"Instant generation unleashes the all-access pass to an enter-anywhere world"*

From sketch to virtual world



MODELING THE VIRTUAL WORLD

Enabling non-experts to create whole virtual worlds in minutes.

Virtual world creation mostly starts with designers sketching their vision. What usually follows is months of 3D modelling and manual fine-tuning every little detail of the world. Novel modelling and interaction techniques can spare much of this routinely work. Our prototype SketchaWorld, for example, generates virtual worlds from simple 2D sketches.

Automated content creation for virtual worlds has been around for years. However, it hasn't really caught on yet, as most virtual worlds are still modelled entirely by hand! This is because current content generation methods are often limited to creating one specific type of feature. They are typically very complex and difficult to use, and hard to steer towards a desired result. Furthermore, the generated content is hard to integrate into a complete and consistent virtual world. This project develops new content generation techniques and user interaction methods for making the automatic creation of virtual worlds accessible, controllable and efficient.

"Procedural sketching makes creating virtual worlds fast, fun and easy"

Interactive procedural sketching

We developed a very intuitive content generation method called procedural sketching, for designers to interactively create their virtual world. Designers paint the landscape with colours representing steep mountain ridges, green hills, barren desert, etc. On top of this, designers draw terrain features, such as rivers, forests and cities, using simple lines and shapes. Meanwhile, as you sketch each element of the virtual world, it is automatically expanded to a realistic terrain feature. Furthermore, all generated features are automatically fit with their surroundings. For instance, a road's embankment is integrated in the landscape, and when it crosses a river an appropriate bridge is inserted in place. Automated content generation techniques as these will certainly never replace manual modelling. SketchaWorld's foremost application is enabling virtual world design by non-specialists, for instance, instructors creating scenarios for serious games. In addition, it is of valuable assistance for applications as concept design, rapid prototyping, and exploration of ideas. Moreover, the generated results can always serve as a sound basis for further enrichment using traditional methods. See www.sketchaworld.com for more details. We are currently cooperating with re-lion BV in making these techniques available for Dutch military instructors, to assist them in creating new scenarios for game-based training.

Mixing manual editing with automatic generation

Using procedural sketching, designers can create complete virtual worlds in minutes. However, to create an environment that exactly matches their intent, designers need more fine-grained control on the generated content, e.g. they may wish to modify the course of a river, shift a street crossing point, or place an important building in a city. We currently investigate the integration of procedural sketching with manual editing operations. For this, in close cooperation with the other Workpackage 1.2 project (see previous page), we are developing semantics-based techniques for maintaining the world consistency after each operation. Main challenges here include preserving past manual changes whenever an area is re-generated, and balancing user control versus automatic consistency maintenance. We believe that a seamless integration of procedural sketching and manual editing can offer designers the best of two worlds, and enable them to freely experiment, eventually creating the virtual world that precisely matches their intent.

Workpackage
1.2 Automatic creation of imaginary worlds

Partners
TNO Defense, Security and Safety
Delft University of Technology

Budget
400.000 euro

Key Publications

Smelik et al. (2010). Declarative Terrain Modeling for Military Training Games. International Journal of Computer Game Technology, vol. 2010.

Smelik et al. (2010). Interactive Creation of Virtual Worlds Using Procedural Sketching. Proc. Eurographics 2010 - Short Papers.

Smelik et al. (2010). Integrating procedural generation and manual editing of virtual worlds. Proc. Fifth International Conference on Foundations of Digital Games 2010.

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Affect in virtual environments

Modeling the Virtual World

Attention to affective qualities improves the validity of virtual environments.

Workpackage
1.3 CAVA: Creating Ambience by Visual and Auditory Means

Partners
Utrecht University
TNO Human Factors

Budget
500.000 euro

Key Publications

Toet, A., Welie, M. van & Houtkamp, J.M. (2009). Is a dark environment scary? CyberPsychology & Behavior, 12(4), 363-371.

Houtkamp, J.M., Schuurink, E. & Toet, A. (2008). Thunderstorms in my Computer: The Effect of Visual Dynamics and Sound in a 3D Environment. In M. Bannatyne & J. Counsell (Eds.), Visualisation, 2008 International Conference (pp. 11-17).

Los Alamitos: IEEE Computer Society. Houtkamp, J.M., Spek, E.D. van der & Toet, A. (2007). The influence of lighting on the affective qualities of a virtual theater. In Predicting the Future, 25th eCAADe Conference Proceedings (pp. 77-84). Frankfurt am Main.

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Virtual environments used for visualisation and training often do not convey the ambience of a real environment, and the urgency of a serious event. Visual and auditory effects can be used to influence the emotional response of a viewer, and enhance the validity and effectiveness of the application.

Virtual environments are used to create convincing environments for training, and visualisations for urban planning. It is important that these environments not only display spatial characteristics, but also elicit affective responses similar to those experienced by a viewer in corresponding real environments. However, on a desktop computer or projection screen much of the visual and auditory information of a real environment is lost. In what way do characteristics of the modeled environment influence the affective response of the viewer, and can we determine this response?

Ceci n'est pas une pipe

Visual effects (dynamics, illumination) and sounds in a virtual environment affect the viewers' response differently than in a real environment. For instance, adding a lot of dirt to a virtual environment will not automatically lead to a negative response; viewers may find it an interesting element in an otherwise rather sterile and dull environment.
Although game technology creates increasingly convincing virtual environments on desktop computers, they are still impoverished versions of reality. Viewers however easily imagine and add information in their minds, which is not present in the model. They decide on for instance season, ambience and materials, using simple cues such as bright colours or plain textures. Modelers can thus influence the ambience of the virtual environments intentionally or unintentionally, while the viewer is not even aware of this.
On the other hand, users have to overcome obstacles with navigation and interaction, which creates distractions and diminishes involvement with the environment displayed. As in films, visual elements and sounds that are important must be emphasized and 'hyper real' to be noticed.
To increase the validity of our studies, we used environments that were developed by E-Semble, VSTEP, and Deltares for training and examination purposes.

Engagement with the virtual world

Our research shows that some very important cues to create a desired ambience in virtual environments, such as darkness, and soundtracks containing real sounds, do not have the expected effect on the viewers' response. We have evidence that these cues are only effective when users are involved with the environment because of personal relevance for them. In our next experiments, we will further explore these issues.

> *"A virtual environment must convey a real atmosphere"*

To attain the required affective response to any virtual environment, the effects on viewers' responses must be considered during the whole design and development process, taking into account users, tasks, and context of use. At the end of this project we will draw up guide lines for design and evaluation that developers can use to create valid 'affective' virtual environments.

Simulating human movement

Virtual Characters

New methods to automatically generate virtual character movements.

In computer games and simulations humans are represented by virtual characters. The realism of their motor behaviour critically determines user engagement and the validity of interactive simulations. Based on the experimental study of human manoeuvring performance, we are developing realistic parameter-based motion models for virtual characters.

Our objective is to identify the principles of natural human maneuvering performance (motor behavior, speed, accuracy). By studying human motor behavior in complex structured real environments, we can derive general parameterized motion models that allow automatic generation of a diversity of virtual character movements. This will enable a more realistic simulation of the motor behavior of autonomous virtual characters, and a more natural interaction with avatars driven by users that are restricted by the limited field-of-view of display devices. Particularly in serious gaming and training applications, this may ultimately lead to increased user engagement and enhanced transfer of skills to the real world.

"Realistic movement of virtual characters enhances user engagement and simulation validity"

Viewing restrictions reduce walking speed

We investigated human obstacle avoidance behaviour under restricted viewing conditions. We varied both the horizontal and vertical viewing angle independently. We found that even a small restriction of the horizontal visual angle causes a considerable decrease in speed while traversing an obstacle course. The results show further that restrictions in both directions affect obstacle avoidance behaviour. However, enlarging the vertical viewing extent yields the largest performance improvements. These results indicate for instance that most commercially available head-mounted displays (HMDs) are not suitable for use in cluttered simulated environments (e.g. military and first responder training applications), due to their limited vertical viewing angles. Our findings can be used to select and develop of HMDs and other display devices with appropriate field of view extents for any given application.

Vertical viewing restrictions increase step length and toe clearance

Using a motion capture system, we are currently analysing several kinematic parameters representing human obstacle crossing behaviour. This enables us to model behavioural changes as shifts in strategy. Our initial results show that, in normal (unrestricted) viewing conditions, humans adopt strategies prioritizing energy conservation and time efficiency. With a restriction of the vertical viewing angle, people appear to counter the risk of tripping by increasing their step length and toe clearance while maintaining their speed, thus sacrificing energy conservation. Additional viewing restrictions appear to cause participants to further reduce their speed and increase their step length and toe clearance even more. Next, we will investigate the effects of viewing restrictions on a range of different manoeuvring tasks and in various circumstances. The results of this research will be useful for implementing realistic manoeuvring performance in virtual environments, and for driving virtual agents.

Workpackage
2.1 Modeling motor behaviour

Partners
Utrecht University
TNO Human Factors

Budget
500.000 euro

Key Publications

S.E.M. Jansen et al. (2008). Effects of horizontal field-of-view restriction on manoeuvring performance through complex structured environments. Proc. 5th symposium on Applied perception in Graphics and Visualization, pp. 189-189.

S.E.M. Jansen et al. (2010). Restricting the vertical and horizontal extent of the field-of-view: effects on manoeuvring performance. The Ergonomics Open Journal, 3, pp. 19-24.

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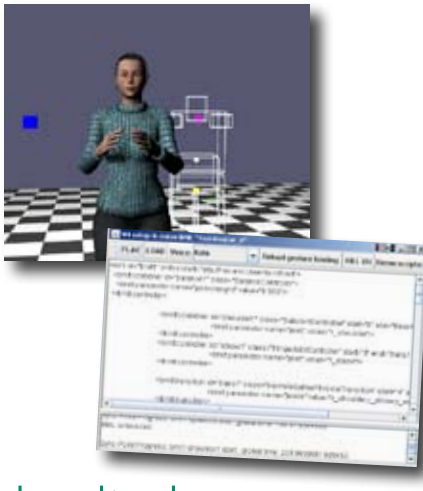
Continuous interactive dialogs with Embodied Conversational Agents



New methods to make Interactive Embodied Conversational Agents appear more natural by continuous and parallel interaction through verbal and non-verbal communication.

VIRTUAL CHARACTERS

Workpackage
WP2.1 Modeling motor behavior

Partners
Human Media Interaction, University of Twente

Budget
500.000 euro

Key Publications

H. van Welbergen et al. (2009). An Animation Framework for Continuous Interaction with Reactive Virtual Humans. Proc. 22nd Annual Conf. on Comp. Animation and Social Agents, pp. 69-72.

A. Nijholt, et al. (2008). Mutually Coordinated Anticipatory Multimodal Interaction. In: Nonverbal Features of Human-Human and Human-Machine Interaction, pp. 70-89.

H. van Welbergen et al. (2009). Real Time Character Animation: A Trade-off Between Naturalness and Control. Proc. Eurographics, pp.45-72.

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Interactive Embodied Conversational Agents (ECAs) are currently used in an interaction paradigm in which the user and the system take turns to talk. If the interaction capabilities of ECAs are to become more human-like and they are to function in social settings, their design should shift from this turn-based paradigm to one of continuous interaction in which all partners perceive each other, express themselves, and coordinate their behavior to each other, continually and in parallel.

The main objective of this project is to develop a continuous interactive ECA that is capable to perceive and generate conversational (non-)verbal behavior fully in parallel, and to continuously coordinate this behavior to perception. We will thereto develop and implement the sensing, interaction and generation components required to realize continuous behavioral interaction.

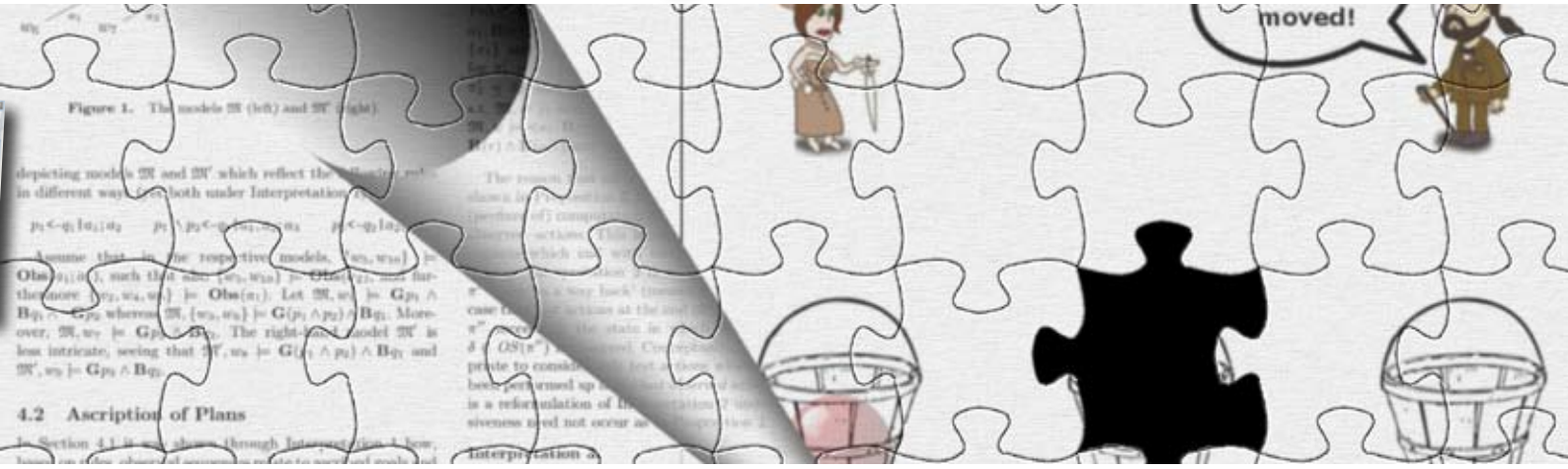
Elckerlyc: A Behavior Markup Language Realizer

We developed the virtual human platform "Elckerlyc" (http://hmi.ewi.utwente.nl/showcase/Elckerlyc) for generating multimodal verbal and nonverbal behavior for Virtual Humans (VHs). Elckerlyc is designed for continuous interaction with tight temporal coordination between the behavior of a VH and its interaction partner. It provides a mix between the precise temporal and spatial control offered by procedural animation and the realism of physical simulation. It is highly modular and extensible, and can execute behaviors specified in the Behavior Markup Language. Elkerlyc allows continuous interaction by direct revision of bodily behavior, based upon (short term) prediction. This leads to a flexible planning approach in which part of the planning can be done beforehand, and part has to be done on the fly. In the latter case, parts of the behavior have already been executed, and other parts can still be modified. We focus on the specification and execution of such flexible plans. We have provided abstractions for the prediction of sensor input and show how we can synchronize our multimodal output to these predictions in a flexible manner. To demonstrate the feasibility of the multimodal output generation part of our system without investing a lot of work in the sensing part, we have currently implemented placeholders for the predictors.

Continuously interacting Embodied Conversational Agents can be interrupted

At the Enterface 2010 workshop a virtual human system will be designed and built, that employs Elckerlyc's continuous interaction capabilities. This ECA will be able to perceive and generate conversational (non-)verbal behavior fully in parallel, and will coordinate this behavior to perception continuously. hus, the ECA responds to (or explicitly ignores) head nods, short vocal utterances such as "yeah" and "hmm" of the user and can try to evoke or encourage such verbal or non-verbal utterances from him or her. Actively dealing with and responding to the user's verbal and nonverbal behavior requires the ECA to be capable of handling overlap, to re-plan and re-time expressions, to ignore interrupt attempts by the user, and to abandon planned utterances (letting itself in effect be interrupted). We will model and implement the sensing, interaction and generation required for this continuous interaction. An evaluation study will be performed to investigate how the newly developed ECA is perceived by human users in terms of politeness and certain personality traits.

Mindreading virtual characters



VIRTUAL CHARACTERS

Logic-based techniques to read others' minds from their observed behavior.

The term 'mindreading' (alarmingly esoteric as it may sound!) in psychological terminology designates an everyday human activity: thinking about what others believe or want. Our goal is to make virtual characters a bit more human by providing them with mindreading capabilities, which are grounded in observable behavior.

BDI-based virtual characters are designed – or even programmed – in terms of their 'mental state', i.e. their beliefs, goals, and plans. This powerful high-level abstraction allows for flexible behavior, and several tools (formalisms & software) exist for specification. However, little work deals with inferring mental states from observed behavior (mindreading), which is a desirable capability for virtual characters that should exhibit awareness of the mental states of others. Our work aims to contribute in this respect, by formalizing mindreading for BDI-based agents in regard to the observed behavior of other BDI-based characters and human players.

"Giving virtual characters mindreading skills will increase their believability"

Different possible pasts

We have developed a generic approach for relating observable behavior to plans, which allows inference of BDI-based agents' mental states from knowledge of rules. This approach deals with plans that are partially observed, which can occur because the agent is still busy with its plan and/or because not all actions are observed. Inference of others' mental states along the lines of our framework is defeasible, meaning that conclusions – although plausible – could be false. In line with this view, a valid interpretation of an observed sequence of actions is that such a sequence represents a set of different 'possible pasts' in which the observed agent had different mental states, of which one was its actual mental state. We have formalized this view for the case in which all actions are observed, in a framework based on dynamic logic.

In the case of human players, a virtual mindreader has even less information available than in the case of software agents. Knowledge of characteristics of the environment are then a possible source of information, and we have investigated this source formally by means of logic, and practically by means of an implementation in the 2APL agent programming language of the classical Sally-Anne false-belief test scenario.

Some explanations are better than others

Inferred mental states can be considered explanations for observed behavior, and the fact that defeasible inference generates multiple different possibilities warrants the search for means to select a 'best explanation' from the possible ones. In this regard we have already considered information from organizational context (roles and norms), and mean to incorporate other sources such as spatial distance metrics or probabilities extracted from past observations. Logical programming approaches come to mind for implementation and evaluation of our methods, of which answer set programming offers some promising possibilities that we intend to explore. Furthermore, recent work in agent programming has focused on the specification of emotions in terms of BDI concepts, and we consider applying our insights to such specifications in order to formalize the inference of (particular) emotions from observed behavior.

Workpackage
2.2, Modeling Cognitive Behavior of Virtual Characters

Partners
Utrecht, Intelligent Systems Group

Budget
500.000 euro

Key Publications

M.P. Sindlar, M.M. Dastani, F. Dignum & J.-J.Ch. Meyer (2008), Mental State Abduction of BDI-Based Agents, Proceedings of the 6th International Workshop on Declarative Agent Languages and Technologies (DALT 2008), pp. 161-178.

M.P. Sindlar, M.M. Dastani & J.-J.Ch. Meyer (2009), BDI-Based Development of Virtual Characters with a Theory of Mind, Proceedings of the 9th International Conference on Intelligent Virtual Agents (IVA 2009), pp. 34-41.

M.P. Sindlar, M.M. Dastani & J.-J.Ch. Meyer (2010), Mental State Ascription Using Dynamic Logic, Proceedings of the 19th European Conference on Artificial Intelligence (ECAI 2010), to be published.

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Explaining virtual character behavior

VIRTUAL CHARACTERS

Explanations of characters to increase trainees' learning of serious games.

Workpackage
2.2 Modeling cognitive behavior of virtual characters

Partners
Utrecht University, TNO

Budget
500.000 euro

Key Publications
Harbers et al. (2009). A methodology for developing self-explaining agents for virtual training. Proc. MALLOW'009.

Harbers et al. (2009). A study into preferred explanations of agent behavior. Proc. international conference on Intelligent Virtual Agents, pp. 132-145.

Harbers et al. (2009). Modeling agents with a Theory of Mind. Proc. international conference on Intelligent Agent Technology, pp. 217-224.

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Behavior of virtual characters in games sometimes seems incomprehensible. But if people are supposed to learn from a game, they need to understand why characters behave the way they do. Therefore, virtual characters are being developed that are able to explain the reasons for their actions.

Serious games are used for training of complex tasks like leadership, crisis management and negotiation. Virtual characters play the trainee's team members, colleagues or opponents. For effective training, the characters need to display realistic behavior. Moreover, it is important that the trainee understands why virtual characters behave the way they do. For instance, why did virtual team members not follow the instructions of their leader, or why did a negotiation partner make a certain bid? New technologies will allow players to actually ask virtual characters for the reasons behind their actions.

Explanation by beliefs and goals

Human explanations have been taken as a starting point for developing virtual characters that are able to explain their behavior. Humans usually explain their own and other's actions in terms of underlying desires, intentions and beliefs. For instance, 'I did this because I wanted to…', or 'he did that because he thought that…'. To obtain similar explanations of virtual characters, they are programmed in a BDI programming language, in which their Beliefs, Desires (goals) and Intentions (plans) are explicitly specified. This makes it possible to explain each action of a character by the particular beliefs, goals and plans underlying that action.

Often a set of goals and beliefs are responsible for one action, but not all of them are needed to explain the action. To avoid too long explanations, a selection of the beliefs and goals must be made. In experiments, subjects were asked to provide feedback on possible explanations of virtual characters. The results showed that for some types of actions beliefs were considered more useful as an explanation ("I thought that …"), but for other action types goals were preferred ("I wanted to …"). Furthermore, it was found that students more often preferred belief-based explanations, whereas teachers tended to prefer explanations in terms of goals.

Effect on learning

Besides a virtual character's beliefs and goals, other factors like theory of mind, emotions or norms may explain its behavior. A theory of mind refers to the ability to attribute beliefs and goals to others. For instance, a character will act differently when he knows about someone else's plans, when he is angry or when he has to obey certain rules. An approach to incorporate these aspects in the BDI models of virtual characters is currently being developed.

Finally, an experiment is being prepared in which the effect of explanations of virtual characters on learning is investigated. Two groups of subjects will play a training game, and afterwards their understanding in the played session will be measured.

> *"Players can ask virtual characters for the reasons behind their actions"*

In between, one group will receive explanations of virtual characters, and the other group will not. The results of this study will show the contribution of explaining virtual character behavior.

Social virtual humans

VIRTUAL CHARACTERS

Enhancing conversational virtual humans with social and emotional capabilities.

The demand for virtual humans that can engage in sophisticated dialogue with players of serious games and training-simulations is rapidly increasing. To facilitate this we aim to build new models of dialogue systems that incorporate social and emotional capabilities. Such enhancements increase the believability and realism of virtual humans.

Virtual humans in serious games and training-simulation need to fulfill the same function as humans in the real life equivalent of such situations. These functions may include performing training-related behaviors and provide explanations for the selection of those behaviors for which they may need to engage in natural conversation with the user. Some applications of virtual humans may concentrate completely on dialogue, for instance in the case of language and cultural learning. At the University of Twente we are working on improving the conversational skills of virtual humans by enhancing conversational virtual humans with capabilities to recognize and display social and emotional behavior.

"By modeling and integrating the relations between cognition and behavior, virtual conversational humans will become more believable and humanlike"

Cognitive modeling

In order to facilitate the enhancement of our virtual conversational humans we needed a solid and plausible framework of the cognitive processes that manages the processing, selection and realization of conversational behavior. In conversations, humans do not merely exchange information but they also engage in a social and emotional relationship. To that end we have examined various conversational virtual human systems and psychological approaches to cognitive, emotional and social processes to gain insight and inspiration. This has resulted in a cognitive model for virtual humans that represents the manner in which humans practically reason about mental abilities. In particular, the model tries to account for basic Theory of Mind modeling, i.e. reasoning about the intentions and emotions of the interlocutor. Through this model a virtual human is able to form beliefs about the world and have goals and intentions it wants to realize through conversational behavior. Furthermore it takes into account the emotional state of the virtual human and the social relation it has with its interlocutor so as to be able to calculate the expected effects of its conversational moves on the other's mental state. Subsequently we have studied how conversational behavior can be associated with the various components in the cognitive model.

Relation between mind and behavior

Currently we are studying how to model the relation between individual conversational behaviors and high level cognitive processes such as intentions, emotions and social roles. Additionally we investigate how the emotional state influences the selection and/or realization of conversational behavior. There is a distinction between the way emotions lead to a certain conversational behavior and the manner in which emotions affect the execution of conversational behavior. The same distinction holds for conversational behavior that is influenced by social rules. By modeling and integrating the relationships between cognition and behavior, virtual conversational humans will become more believable and humanlike.

Workpackage
2.2 Modeling Cognitive Behavior of Virtual Characters

Partners
Utrecht University
University of Twente
TNO

Budget
500.000 euro

Key Publication
B. van Straalen et al. (2009) Enhancing embodied conversational agents with social and emotional capabilities. In "Agents for Games and Simulations", F. Dignum et al. (eds.), pp. 95-106

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Virtual crowds

VIRTUAL CHARACTERS

New techniques to populate virtual worlds with thousands of characters.

Workpackage
2.3 Natural paths for virtual entities

Partners
Utrecht University

Budget
500.000 euro

Key Publications

I. Karamouzas et al. (2008). Adding variation to path planning. Computer Animation and Virtual Worlds 19, pp. 283-293.

I. Karamouzas et al. (2009). Indicative routes for path planning and crowd simulation. Proc. fourth international conference on Foundations of Digital Games, pp. 113-120.

I. Karamouzas et al. (2009). A predictive collision avoidance model for pedestrian simulation. Proc. Motion in Games, pp. 41-52.

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Contrary to real worlds, many game worlds contain only very few people. As a result the worlds feel uninhabited. To give game worlds a lively feeling we need to simulate large crowds of virtual characters. New techniques have been developed for this that are efficient and lead to natural crowd behavior.

A basic operation that virtual characters must perform is navigating from their current location in the virtual world to a desired new location. This problem is called the path planning problem. Often multiple characters move in large groups or crowds in the same environment, in which case we talk about crowd simulation. Path planning and crowd simulation play an important role in the immersion that a player experiences in a game. Existing real-time crowd simulation approaches fail to deliver motions that are natural. This project studies new, practical path planning and crowd simulation algorithms that efficiently generate convincing paths.

Indicative routes

We developed a new approach to path planning that is very fast and flexible. During a preprocessing phase we compute a network of routes through the environment, similar to waypoint graphs that are often used in games. But we do not follow these routes directly! The paths are only used as an indication. With each route we store a collision-free corridor. This corridor gives the character flexibility to choose its path. While it globally follows the indicative route to its goal, locally it can deviate from the path, as long as it stays within the corridor. This approach can plan thousands of paths simultaneously with little CPU usage.

We use this approach as the basis for our crowd simulation technique. While characters globally follow their indicative routes they must avoid other characters. We developed a new approach for character avoidance based on observations of behavior of real people. The characters predict collisions and take early action to avoid them by making small changes to their direction and speed. Recently we extended this to characters walking in pair and triples. The resulting motions are much more natural and we can simulate crowds of thousands of people at interactive frame rates.

Mood influences walking behavior

In different situations crowds of people behave differently. For example, in a railway station many people stand still while others run. But in a shopping center people tend to wander around slowly. We currently investigate these different types of behavior and we will design algorithms to simulate different types of crowds. Also the personality, mood, and age of people strongly influence their walking behavior. Angry people walk faster and are less willing to deviate from their path. People that are distracted, for example when using a mobile phone, walk slowly and pay little attention to other people. We will construct a general framework to deal with these different types of people in a crowd. Finally we will study replanning, which is required when a path that is chosen by a character is blocked. Integrating all these elements will lead to much improved and more generic crowd simulation software.

"Realistic simulation of crowds will considerably improve the immersion in game worlds"

Simulating virtual characters

INTERACTING WITH THE WORLD

New techniques that make virtual characters perform mundane tasks more realistically.

Natural movement of game characters is very important in games and simulations. However, specific tasks such as opening doors or picking up a gun are often poorly animated in games. We have developed techniques that make the character perform these tasks more realistically.

Characters in games generally can do many different actions such as walking, running, or jumping. A common technique to obtain realistic animations is by using motion capture. By tracking the motions of an actor it is possible to have a game character perform the exact same movement as the actor. However, the more actions a character should be able to perform, the more motion capture recordings are needed, leading to huge motion databases. Furthermore, a lot of manual work is required to ensure that transitions between motions look natural. We focus on finding automatic techniques for generating realistic character motion.

"Natural movement of virtual characters is very important in games"

The stepspace

In our technique, motions are generated separately for the upper body (picking up an object) and lower body (walking). The upper body arm motion is created using techniques from robotics. The lower body motion is created by combining and reusing recorded walking motions. After the animations for both the upper and lower body are created, they are stitched back together.

The input for our animation system is a sequence of foot placements, which can be drawn by an animator or calculated automatically from a path that the character should follow. We store a database of walking motions which are automatically separated in different footsteps. New motions are then created by smartly interpolating between these footsteps in the database, combined with a fast parameterization scheme that describes the footsteps using only a few parameters. We then combine the different footsteps to get the final animation. Our technique is fully automatic and needs no editing or post-processing. Furthermore, our technique is real-time. Because we separate the lower body from the upper body, we can now combine upper body motions with the generated motion to perform tasks while walking such as picking up objects or opening a door.

The next step

Many game companies can benefit from this new technique. First of all, the technique can generate animations that walk and pick up objects simultaneously, which is not possible with current techniques. Second, our technique requires less recorded motions. Game companies can therefore spend more time and money on other aspects of the game. We are currently looking into applying a similar technique to the upper body to generate realistic upper body motions based on a small corpus of recorded data. This way, an animator can generate motions based on how a character interacts with the environment fully automatically without having to worry about how the motion is constructed. Furthermore, we are investigating how physical properties can be incorporated in the system, so that the animation is adapted automatically to the constraints of the environment.

Workpackage
3.1 Navigation and Manipulation

Partners
Utrecht University

Budget
500.000 euro

Key Publications

B. J. H. van Basten et al. (2010). Combining Path Planners and Motion Graphs. Computer Animation and Virtual Worlds, to appear.

A. Egges et al. (2010). One Step at a Time: Animating Virtual Characters based on Foot Placement. The Visual Computer, 2010. Special issue of selected papers from Computer Graphics International.

B. J. H. van Basten et al. (2009). Evaluating Distance Metrics for Animation Blending. Fourth International Conference on the Foundation of Digital Games (FDG 2009).

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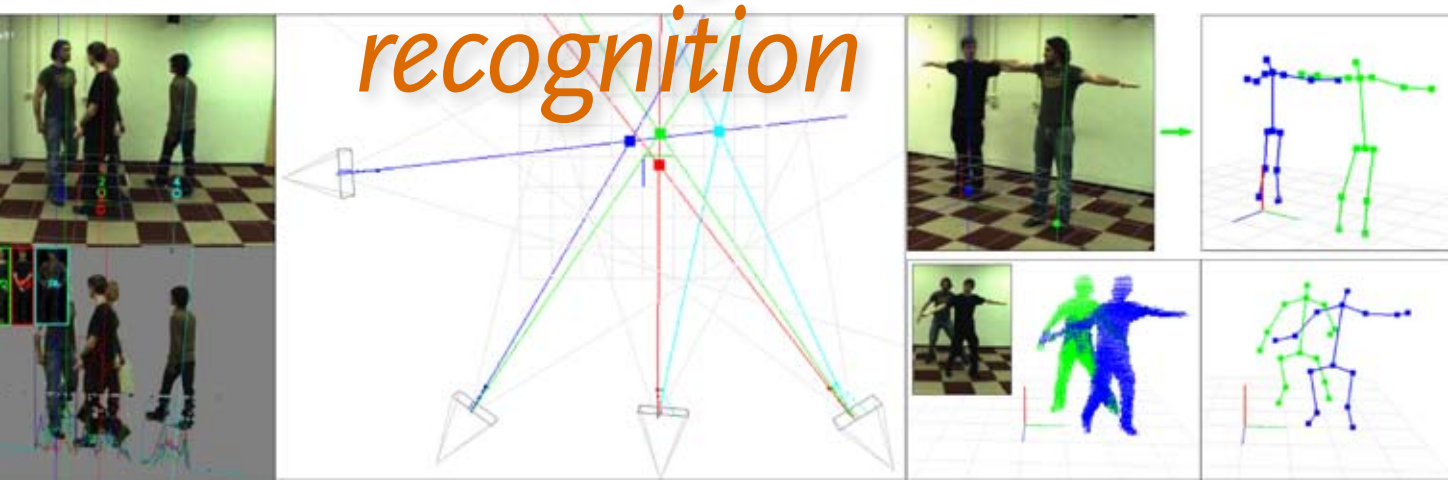
Video-based 3D human motion recognition



INTERACTING WITH THE WORLD

New techniques for 3D tracking of people and understanding poses.

Workpackage
3.2 Detecting, interpreting and affecting user behavior

Partners
Utrecht University
Technical University Delft

Budget
500.000 euro

Key Publication
Luo et al. (2010). Human Pose Estimation for Multiple Persons Based on Volume Reconstruction. 20th International Conference on Pattern Recognition (ICPR), 2010.

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A new way to interact with a computer, is to simply use the player's poses, which are tracked and interpreted via cameras. We develop new techniques for accurately tracking people and recognizing their poses, even when they are occluding each other. No special markers on the bodies are needed to track the people.

Although current computer vision research has achieved promising results in interpretating the pose and gestures of a single person given multiple video sequences, intepreting the poses of multiple-people in a relatively dense group is still an open problem. The key difficulties are the inter-person occlusion and limb ambiguities which hamper the interpretation. This project studies and develops new techniques for video-based human pose and gesture recognition. We are developing an efficient and robust platform for multiple-people tracking, body model construction, pose recognition and gesture understanding, all in 3D. We aim at utilizing this platform in human-computer interaction applications like in pose-driven games or gesture-driven presentations.

Beste visibility views

Using multiple cameras, we reconstruct the 3D volume data of moving people in a target scene. The reconstruction is automatic and real time. The volume data consists of the information of the moving people and their poses. The goal is to track the movement and to recognize the poses. To be able to track the movements, first the locations of each individual in the 3D world has to be determined, and then track the location of the next frame by considering the current frame. The basic ideas are (1) to use the appearance of the target person in 2D images, (2) to estimate the 2D location of the person in all views, (3) to backproject the 2D locations from all views onto the 3D world to have an intersection, representing the location of the target person, (4) to employ the location of the previous frames to improve the robustness of the estimation. To overcome the inter-person occlusion problem, a technique based on the best visibility

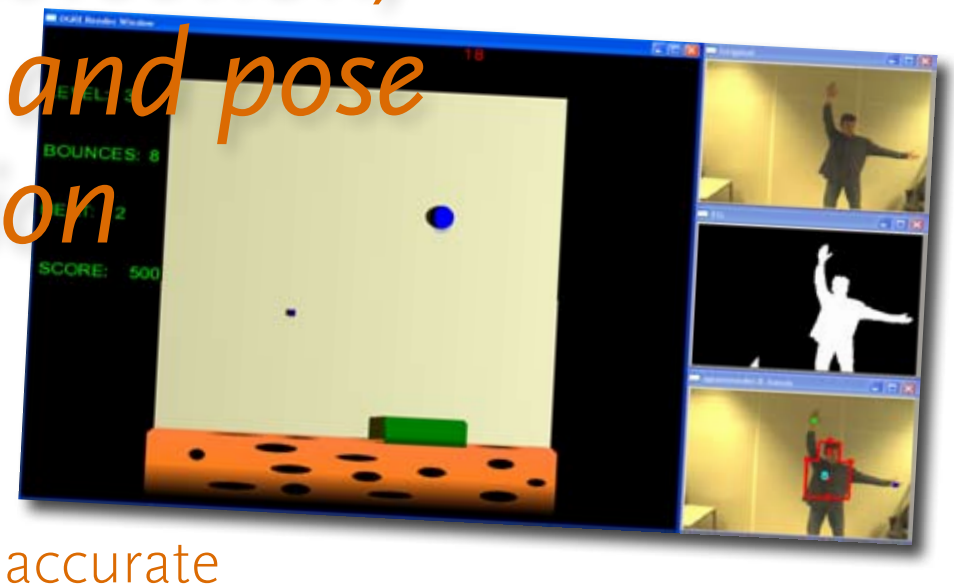
> *"New computer vision techiques will change the way of human-computer interaction"*

of the views is introduced. The visibility ranking is computed based on run-time measurements of person-person and person-view relative positions. By fusing the information from two views with the best visibility, more robust tracking of people under severe occlusions can be achieved. Having tracked the location of each person, then we can segment the volume data with respect to each person, by fitting a 3D skeleton model to the 3D data. Finally, as a result, the poses of each person can be identified.

Gestures and interaction

We will update the tracking methods to a more flexible framework, to enable automatic initialization, and to handle people who enter or leave the scene. We will further improve our prototype multiple-people pose estimation, by integrating more cues. These include the appearance of persons, and motion prediction. We will further extend multi-person pose recognition by using joint locations as feature to classify different poses. While multiple people pose recognition is further elaborated, interpretation of multi-person interaction will be a next step. For the evaluation of our methods, we will develop demonstrators such as a gaming environment with video input, and a gesture-driven slide show presentation framework.

People detection, tracking and pose recognition



INTERACTING WITH THE WORLD

Fast and accurate modeling human upper body pose.

A well-known video-based application is man-machine interaction, in which people can use their facial expressions, gestures and poses to control e.g. virtual actors or (serious) games. We are developing new methods that allow players to get rid of controllers and play games using intuitive body movements and poses.

Although there have been a significant number of investigations on human motion capture, most of them are marker-based. People need to wear specific suits with markers on it to track the movement of different body parts, which is not convenient for real applications. To solve this problem, marker-less human motion capture system is desired. Compared with a single person situation, multiple person tracking and pose estimation has more challenges, such as dealing with occlusion between persons and self occlusion. The objective of the project is to develop new algorithms wich can detect, track, and model a small group of people in an indoor environment.

Multiple person upper body pose tracking

We propose a real time system which can detect, track people, and recognize poses. In the people detection, tracking and pose recognition system, body parts such as the torso and the hands are segmented from the whole body and tracked over time. The 2D coordinates of these body parts are used as the input of a pose recognition system. By transferring distance and angles between the torso center and the hands into a classifier feature space, simple classifiers, such as the nearest mean classifier, are sufficient for recognizing predefined key poses. The single person detection and tracking is extended to a multiple person scenario. We developed a combined probability estimation approach to detect and track multiple persons for pose estimation at the same time. It can deal with partial and total occlusion between persons by adding torso appearance to the tracker. Moreover, the upper body of each individual is further segmented into head, torso, upper arm and lower arm in a hierarchical way. The joint location and angles are obtained from the pose estimation and can be used for pose recognition.

Mutiple person pose recognition

We will further extend multiple persons pose estimation into pose recognition. The goal is to use joint locations as features to classify different poses. We will also investigate pose detectors to reject non-pose examples based on the proposed features. The approach is to first separate the poses and non-poses, then to clearly distinguish different poses from each other. We will focus on improving the accuracy and robustness of the existing system. The emphasis will on the use of multiple cameras and information fusion. A vision based human pose detection system makes controller free games possible.

"A vision based human pose detection system makes controller free games possible"

Workpackage
3.2 Detecting, interpreting and affecting user behavior

Partners
Delft University of Technology
Utrecht University

Budget
500.000 euro

Key Publications
F. Huo, et al. (2009). Markerless human motion capture and pose recognition. International Workshop on Image Analysis for Multimedia Interactive Services, pp. 13-16.

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Brain controlled navigation through virtual worlds

INTERACTING WITH THE WORLD

New techniques based on brain signals aim to make navigation through virtual worlds more intuitive.

Workpackage
3.3 A Brain Connection Device for Education, Feedback, Gaming, Hands-free Interaction, Joy, Know-how, Learning and More.....

Partners
TNO Human Factors
Utrecht University

Budget
500.000 euro

Key Publications

Brouwer, A.-M. et al. (2010). A tactile P300 brain-computer interface. Frontiers in Neuroscience, 4:19, 1-12.

Thurlings, M.E. et al. (2010). EEG-Based navigation from a Human Factors perspective. In: D.S. Tan & A. Nijholt (Eds.) Brain-Computer Interfaces, Human-Computer Interaction series, pp. 117-132. London: Spinger-Verlag.

Coffey, E.B.J. et al. (2010). Brain-Machine Interfaces in space: using spontaneous rather than intentionally generated brain signals. Acta Astronautica, 67, 1-11.

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Controlling your movement through a virtual world can be a cognitively demanding task. To make navigation more intuitive, controllers based on hand and body movements such as the Nintendo Wii were recently introduced. The future generation of game controllers aims to be even more intuitive by directly translating brain signals into navigation commands.

Traditional navigation interfaces such as joysticks and gamepads are often not intuitive. This means that users either have to invest many hours of training or allocate significant cognitive resources to the navigation task, reducing overall task performance. To make navigation more intuitive, this project looks into the possibilities of using brain signals for navigation. Our goal is to implement hands-free navigation in at least three dimensions (left, right, rotate). The ultimate goal is that the user's cognitive resources could be fully used for the content of the game instead of the interaction with the interface.

Brain Computer Interfaces

Brain Computer Interfaces (BCI's) enable direct communication between the brain and a computer and come in many different sorts. We are developing passive BCIs: BCIs that use the brain's reaction to specific probe stimuli. The advantage of passive BCIs is that they do not require training but tap into the normal responses of the brain to for instance stimuli that are of particular interest. However, these brain responses are still under voluntary control of the user, making them well suited for BCIs. We explore several types of probe stimuli and brain responses. One of these brain responses is the Steady State Evoked Potential (SSEP). SSEPs are induced by probe stimuli that for instance flicker with a specific frequency. The flicker frequencies can be distilled from the brain signal. When multiple probe stimuli (each with a different frequency) are presented, the user's attention affects which of the stimuli has a stronger effect on the brain signals. In other words: the user can choose from several options by paying attention to one of several probe stimuli. So far, we have developed and tested a BCI based on a visual SSEP. However, the disadvantage of visual probe stimuli is that they require eye movements and may interfere with the visual game environment.

"Future generation game controllers will be hands-free"

Is navigation just a matter of gut feeling?

To overcome the disadvantages of a BCI based on visual probe stimuli, we started to develop BCIs based on touch stimuli. The sense of touch is often underutilized in gaming and does not require (the equivalent of) eye movements. We are now looking into the feasibility of using tactile stimuli with different vibration frequencies as probe stimuli. Of special interest is a set-up in which the probe stimuli are placed inside a belt worn around the user's torso. Choosing left, right, forward, and backward may become very intuitive this way, bringing us a step closer to our goal of hands-free, intuitive navigation. We are also exploring the possibilities of combing visual and touch stimuli to see if this increases the speed or quality of the BCI.

Adapting the game to the world

LEARNING WITH SIMULATED WORLDS

Keeping the trainee on track

Computer games are frustrating if they are too difficult, but boring if they are too easy. Researchers at Utrecht University are working on computer games that adjust to the skill level of the user on the fly. This way games are just challenging enough for that particular person.

One of the most important factors in making computer games fun is making sure that they have the right difficulty level for the player. Most games can be played at different difficulty levels, which you can chose before you start the game. This way you need to know how good you are at the game before you start playing the game. Different people also increase their skill level at different rates. If the increase in skill level is different than the game designer expected then the game will still become too difficult or too easy for the user.

Continuous matching difficulty of tasks and skill level

We created a framework for creating games that are able to keep track of the skill level of the player and adjust accordingly. We estimate the skill level of the player by dividing the game in small parts and measuring the performance of the player on every part that is finished. Really different tasks are chosen according to the skill level of the user. For example, a game level with lots of aiming tasks if the player needs to improve its aiming skill. Game designers usually create a nice story that the player experiences while he is playing the game. But if different players get different tasks according to their skill level then the ordering of the storyline might change and possibly ruin the experience for the player. The developed system allows games to adjust to the user while making sure that the storyline, created by the game designer, is preserved. For example a character with a broken leg cannot suddenly walk again to make the game easier. They also makes sure that parts of the game that should be more challenging remain more challenging for the player. Beschrijf hier de resultaten. Geef ook eventuele samenwerking met bedrijven aan (voor zover niet binnen een KTP).

"Challenging the user at the right level makes computer games fun"

Proof of concept

At the moment we created a proof of concept of the model and are developing a custom environment in which we can experiment with the theoretical framework developed so far. We plan to submit the progress and gained knowledge from this face to the Agents for Games and Simulations workshop and to AAMAS or a more gaming oriented conference. Journal submissions will also be considered.

Workpackage
4.1 Adapting the game to the world

Partners
Utrecht University

Budget
500.000 euro

Key Publications

Joost Westra,et al (2010). Guiding User Adaptation in Serious Games, Agents for Games and Simulations

Joost Westra,et al (2010). Keeping the Trainee on Track, IEEE Conference on Computational Intelligence and Games

Joost Westra,et al (2009). Adaptive Serious Games Using Agent Organizations, Agents for Games and Simulations (pp. 206-220)

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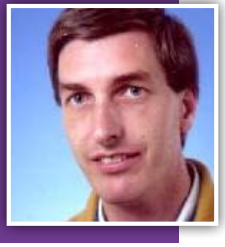

Learning from games

Learning with Simulated Worlds

New models that enable designers to improve specific learning results.

Workpackage
4.2 Design rules for learning through simulated worlds

Partners
Utrecht University

Budget
1.000.000 euro

Key Publications

J. Raessens (2010). A taste of life as a refugee: How serious games frame refugee issues. In: Changes in Museum Practice. New Media, Refugees and Participation, pp. 94-105.

J. Raessens (2009). The gaming dispositif. An analysis of serious games from a humanities perspective. In: Serious Games: Mechanisms and Effects, pp. 486-512.

S. Lammes (2009). Terra incognita: Computer games, cartography and spatial stories. In: Digital Material. Tracing New Media in Everyday Life and Technology, pp. 223-235.

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Serious games can enable players to acquire and improve domain specific knowledge and sharpen cognitive skills such as spatial abilities, media literacy, decision making and problem solving. New models have been developed that can help game designers and developers to discuss and improve the design and learning effects of educational games.

Although serious games have become a very popular medium, developers still require theoretical models that can help them to improve the design and thereby the learning results of serious games. This research wants to fulfill this need by focusing on three specific topics: how meanings are made through games and game play, how narrative structures can be designed to improve learning processes, and how rhetorical strategies can be designed to convince players of certain perspectives (e.g. political games), or behavioural changes (e.g. health games). With the insights gained from this research, we will formulate specific design rules for game-based learning.

Persuasion and learning

Building on the analysis of the medium specificity of serious games, we created a heuristic tool or model – the gaming dispositif - that takes into account the interplay between technical, textual, contextual, psychological as well as social processes involved in the game-playing situation. This model enables us, for example, to understand how serious games trigger different educational readings, depending on the context in which they are embedded. We also developed a theoretical model that can be used for the analysis and design of emergent narratives in serious games. Breaking with a classical narrative approach, this model focuses on space and spatial exploration, and on how games offer players firsthand narrative experiences in the here-and-now. Finally, we studied the qualities of serious games that enable, promote, limit or impede persuasion. We are using these insights to formulate effective and efficient strategic guidelines for persuasive game design. Taking into account the differences and similarities between persuasion, manipulation and learning, this model can elucidate why and how serious games can be so exceptionally persuasive. Designers can use these models to improve specific learning results.

"Food Force: an educational game that rocks! Informative, and very enjoyable to play"

Social network games

To be able to formulate specific guidelines for designing educational games, we will extend and improve the new models we have developed so far. A specific issue of learning is that it should be accountable and measurable. That's why we want to start with an empirical evaluation of how serious games make use of narrative structures and rhetorical strategies to engage players in learning processes. We will not only summarize the empirical evidence on the effectiveness of existing best practices of serious games (e.g. Food Force), but also participate in the design of new games (e.g. Schiphol SmartGate). The latter will be done in close collaboration with gaming companies in a so-called knowledge transfer project. Furthermore, we also want to include social network games in our research (e.g. FarmVille). We will bring together knowledge on social networking mechanics and serious game design fundamentals to investigate the potential of social networks such as Facebook for game-based learning.

Serious game design

LEARNING WITH SIMULATED WORLDS

Improving the design of serious games from a cognitive standpoint.

Serious games are a fun, but as of yet inefficient way of teaching educational material. In part this is because very little is known scientifically of what makes a well-designed serious game. We are empirically investigating which game design techniques work and which don't.

All games revolve around learning. Much of what makes a game fun in the first place is learning to overcome obstacles, how to defeat difficult enemies and solve complex puzzles. As good games scaffold and regulate this learning process fluidly, inserting serious material in a good game would lead to an effective serious game. This is the theory. In practice however, many serious games struggle to reach their full potential. Games are difficult enough as they are; adding difficult educational content requires a clear notion of the cognitive implications of the game design and finetuning these.

Game Discourse Analysis

To facilitate this clear notion, we created the Game Discourse Analysis, a method and a graphical way of describing the characters, events and implications for the player's cognitive system in the game. With this we were able to discern critical moments in a game narrative that allow evoking curiosity in the player by inserting certain information, and found out that this change in the narrative enhanced curiosity of players and improved recall later on.

Code Red Triage

Different game design techniques can hypothetically be used to finetune the cognitive load imposed by a game and to improve learning from the game. We created a serious game, Code Red Triage, which trains medical first responders in a crisis situation. With this game, we systematically vary techniques such as cueing, the information presentation rate and narrative structure, to determine the effect on learning gains and enjoyment of the game. We already found out that using cues--guiding the attention of the player via auditory or visual hints and often used in entertainment games, may actually be harmful, or at least not effective, in serious games.

Serious serious game design

This begs the question: does good game design actually mean good serious game design? In entertainment games, the complexity of the game progressively builds up, with players receiving new abilities and encountering slightly more difficult enemies as they go along. However, this could also make the player a lazy learner, never being urged to overthink the whole picture. We are now examining what way of increase in complexity works best for serious games. In addition, we are engineering the predictability of the narrative structure of our serious game, to see if this can encourage the player to think actively about the presented information, and thereby boost the learning gains of a serious game.

"Does good game design actually mean good serious game design?"

Workpackage
4.3 Cognition-based learning principles in serious games

Partners
Utrecht University

Budget
500.000 euro

Key Publications

E.D. van der Spek et al. (2010). Code Red Triage, Or COgnition-based DEsign Rules Enhancing Decisionmaking TRaining in A Game Environment. British Journal of Educational Technology.

E.D. van der Spek et al. (2010). Attentional Cueing in Serious Games. Proc. 2nd IEEE conf. on Games and Virtual Worlds for Serious Applications, pp. 119-125.

P. Wouters et al. (2009). Cognition-based learning principles in the design of effective serious games: How to engage learners in genuine learning. 2nd European Conf. on Games Based Learning, pp. 517-524.

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Evidence-based learning in serious gaming

LEARNING WITH SIMULATED WORLDS

How to optimize, measure and validate true learning effects of educational serious games.

Workpackage
4.4 Transfer of Gaming

Partners
TNO-Human Factors

Budget
500.000 euro

Key Publications

Toet, A et al (2008). Cybersickness and desktop simulations: field of view effects and user experience, in: JJ Güell, M Uijt de Haag (Eds.), Enhanced and Synthetic Vision 2008, SPIE-6957. The International Society for Optical Engineering, Bellingham, WA, USA (2008) pp 69570P-1 - 69570P-11.

Bos, J.E. et al (2010). The effect of internal and external field of view on visually induced motion sickness. Applied Ergonomics 41, pp 516-521.

Korteling J.E. et al Report TNO-DV 2010, TNO Human factors (in press).

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Serious gaming may reduce the cost of training, enhance job satisfaction and labor productivity, and thus may be a highly effective and satisfying tool for education. However, to what degree is this possible, what determines learning benefits and how can this be measured and proven?

Transfer of gaming (ToG) of educational games concerns the degree to which skills, knowledge, and attitudes acquired by playing a game can be effectively used in real (practical, professional) situations. In this workpackage, methods for the determinantion of ToG are formulated and developed, as well as tools, guidelines and concepts affecting ToG.. In addition, experimental research is carried out to verify claims (e.g., concerning learning effects) and to test hypotheses (e.g., about cybersickness). This knowledge on (improvement of) ToG helps game designers and developers to build the right games for the right purposes.

Cybersickness, military tactics and F16 pilots

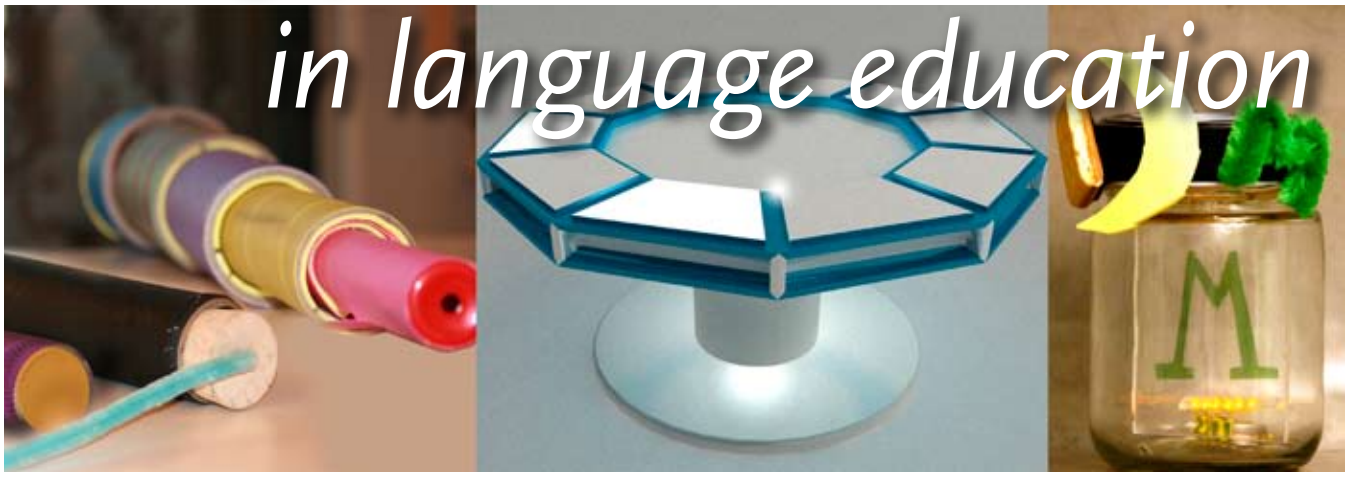
A review of the literature has been carried out describing motivational and educational aspects of serious gaming as well as methodological aspects of ToG measurement. This work includes a taxonomy predicting effects of game characteristics on transfer of gaming and a Stepwise Reference Framework. This latter tool entails a stepwise approach for the design, specification and evaluation of serious games from a combined didactical and cost-effectiveness point of view.

Next to this theoretical study, several experimental studies have been carried out. Cybersickness represents sickness caused by viewing dynamic image content as generated by video games. In order to get more grip on this phenomenon several hypotheses have been formulated and experimentally tested and an explanatory framework was developed. Using a military tactical shooter game (VBS2) for platoons and their commanders, we have furthermore shown that students became more motivated and active learners and performed better, especially in military tactics. Finally, a transfer of training study was conducted in TNO's high-fidelity F-16 flight simulator. The results of this experiment show that Falcon 4.0 (a PC based F-16 flight game) gamers perform substantially better on all measured tasks compared to Microsoft Flight Simulator gamers and to non-flight gamers. The aforementioned results provides rules, principles and tools for an adequate evaluation method aimed at measuring ToG and improving ToG in educational programs.

Flow and engagement

Next to the training of typical perceptual-motor or procedural skills, serious gaming may also be very beneficial for enhancing motivation, engagement and typical professional attitudes. Therefore, after having analyzed the complete set of data of the Falcon 4.0 study, we will further extend on this ToG study. In collaboration with the Open University new tools to measure the performance of the F16 gamers will be developed and applied. These tools measure performance on different behavioral scales, such as flow, situational awareness and engagement. Based on theoretical analyses and previous observations we expect to find that certain (but not all) task aspects of this very complicated professional job, i.e., the execution of coordinated F16 fighter jet missions, will show substantial transfer from the game to "real" task. In addition we will further work on publication and dissemination of the results and conclusions.

Using your senses in language education



EDUCATION

Children learn words and find associations in narrative play.

StoryBOX facilitates game-based language learning. It enables those who teach group three of Dutch elementary schools to create a flexible, physical environment in which pupils explore language using technologically enhanced interactive objects. Pupils will learn to express themselves by physically linking words and concepts to their everyday lives.

Research shows that, in Dutch elementary schools, the results of language education are disappointing. In particular non-technical aspects, such as comprehension, are hard to teach. Waag Society's Pilot Education StoryBOX focuses on contextual language education. StoryBOX consists of tangible, technologically enhanced objects that facilitate learning by playing. This engages pupils to explore language, in an educational format that bridges formal and informal learning. StoryBOX stimulates the use of the senses in language education.

Interactive blocks

StoryBOX creates an accessible and intuitive gaming environment for learning language and meaning. Gaming environments provide a safe and exciting place to experiment and explore the world. By playing games, cognitive and behavioral processes are being practiced, such as problem solving, vocabulary development and social skills. StoryBOX adds value for both teachers and pupils, by providing them with innovative tools. Pupils will connect words and concepts to their everyday lives, using the technologically enhanced objects. Among the StoryBOX tools are interactive blocks that pupils can use to collect, trade and publish words and associations. These blocks are containers for letters, words, sounds, and images that children find in their everyday lives. The blocks are enhanced with LED displays, sensors, small cameras or recorders and other electronics. Part of the process is to stimulate children to create and tell their own stories. Children, age six and seven, enjoy narrative play, which StoryBOX stimulates by bringing familiar objects and new words to their play.

"Gaming environments provide an exciting place to explore the world"

Media artist Marloeke van der Vlugt helps designing the interaction of StoryBOX' components and developing game scenarios. Recently an advisory panel of teachers and pupils has been installed.

Prototyping

Waag Society engages in an iterative process of designing concepts, mock ups, demos, and prototypes together with the prospective users: prototyping. Prototyping fulfils an important role in the design process. By quickly materializing concepts, new ideas are generated and tested. Prototyping StoryBOX will result in a fully functioning StoryBOX prototype that will be evaluated in classrooms. The University of Amsterdam's Teachers College (ILO) will measure the actual learning effects.
Market research will be performed, an exploitation model will be developed, and a consortium will be formed for producing, selling and supporting StoryBOX. The market for StoryBOX primarily consists of elementary schools, however preschool education (nursery school), cultural institutions like science museums (e.g. Nemo) and festivals (e.g. Cinekid) may benefit as well.
Results of StoryBOX will be widely disseminated.

Pilot:
Education

Partners
Waag Society
Utrecht School of the Arts (HKU)

Budget
548.000 euro

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Playing with physics

EDUCATION

Innovative GATE pilot showcases the use of games in the classroom.

Pilot:
Education "CarKit"

Partners
Utrecht School of the Arts (HKU)
Waag Society

Budget
625.000 euro

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The GATE Education pilot attempts to showcase the future of education through demonstrating the possibilities of game based learning in the classroom. HKU's R&D program Applied Game Design, developed a race game that helps players to understand Newtonian physics. The game, called Carkit, proves that serious games can be fun...

"Understanding Newtonian physics through playing games"

The main goal of the pilot is to showcase the possibilities of game based learning to the educational sector and creative industries in a demo based on state of the art game design & development insights and techniques. CarKit demonstrates the potential of the application of games in the classroom in the form of a race game that enables children to play with the laws of physics. Furthermore the pilot aims at a better understanding of the (im)possibilities of the adaptation of educational content to a game context and to share this understanding with the educational sector and creative industries.

Towards a design methodology for educational games

The results of the GATE Education pilot consist of a fully playable demo of a state of the art race game validated in Dutch classrooms. HKU designed and developed a game as an addition to and embedded it in existing educational methods. The design posed several challenges: the game had to be fun to play and a rewarding experience in itself, but also had to succeed in motivating players to understand Newtonian physics and succeed in transferring the appropriate knowledge. Successfully translating educational content into game mechanics and gameplay is difficult. By using a highly iterative design method, allowing us to constantly validate concepts and design decisions both in relation to player experience and the educational context, we succeeded. At the moment we are close to delivering a demo that successfully faces the posed challenges. Apart from CarKit and its abilities to showcase the future of game based learning, the value of this pilot also lies in the knowledge we gained in regard to design methods for educational games. We were able to share our insights in regard to the design methods and design processes of educational games in several papers, presentations, demonstrations, workshops and symposia.

Validating and scaling

The educational sector and creative industries have an urgent and vast need for insights into the mechanisms and effects of educational games and the translation of these insights in the form of design methods and business cases. At the moment we are testing CarKit within the classroom together the Freudentahl Institute for Science and Mathematics Education (Utrecht University). Furthermore we are developing a business case around the CarKit concept. This case also includes the translation of the CarKit concept to other educational domains.

Solve a crisis in 8 minutes!

SAFETY

Learn more about a crisis management process in eight minutes.

At this moment mayors have one major ways to train for possible future crisis situations: large table-top exercises. We came up with an additional way based upon serious gaming, brief, single-player and anonymous: "Play and improve the process". Crises change but a good process goes a long way.

To be able to advise on a game for strategic managers, like a mayor of a BT, we first established the learning goals for this group. This was done in 2009 together with a focus group consisting of subject matter experts. The learning goals chosen were 'Setting priorities and making underpinned decisions –under time pressure'. For this game, to be a real addition to existing training methods there were specific conditions: (1) the game supports learning in max. 15 minutes; and (2) is a single-player game, to make it easier to arrange a training session and guarantee anonymity.

"Crisis management training for Mayors; quick & on your one"

Change a paper prototype into a mockup

To design a serious game, a game that allows players to learn, we work with three groups of experts in our team: 1. Game experts; to make a game entertaining, motivating and look good; 2. Educational experts; ensure that the learning goals can be reached by playing this game; 3. Domain experts, help the team with the content of the scenarios.
The team built a paper-based game first. The focus group could play a first round in November 2009. With some brief revisions we were able to take our game to a next level in 2010: a first digital version, a mock-up.
While the developers were looking for ways to translate the (paper) game-elements into digital components (mock-up), the educational experts set up an experiment. With 24 students from the Haagse Hogeschool (Integrale Veiligheidskunde) the paper-based game was played, to establish how the game affects the way in which people learn. Students filled out a digital questionnaire (before and after the game) about four elements of Self-Directed Learning (Control, use of Learning Strategies, Reflection, and use of Social environment) and some questions about motivation and self-efficacy. We found that where most tested elements did not change, there was (expected) improvement in the element Reflection.

All Dutch Mayors

The mock-up will be evaluated during the summer with a number of (deputy) mayors. The challenge for 2010 will be to prove that the effect found in the paper-based game, also applies to the digital version. All the feedback collected during the summer will be used to create the final game prototype. This prototype will also have more graphic details and meet the maximum possible of the learning goals and conditions as determined in the focus group meetings. In a final evaluation, probably late 2010 – early 2011, this game will be tested again with a group of mayors.
Having created a game that allows mayors to add another way of training to their curriculum, the team has only one wish left; Continue to develop the game by adding other learning goals and audiences, so that all Dutch Mayors and board members use this game to prepare for crises.

Pilot:
Safety

Partners
Utrecht School of the Arts (HKU)
Thales, TNO

Budget
2.050.000 euro

Key Publication
H. Stubbé (2009) Human factors in the process of game concept design. Poster at D-CIS Human Factors Event 2009

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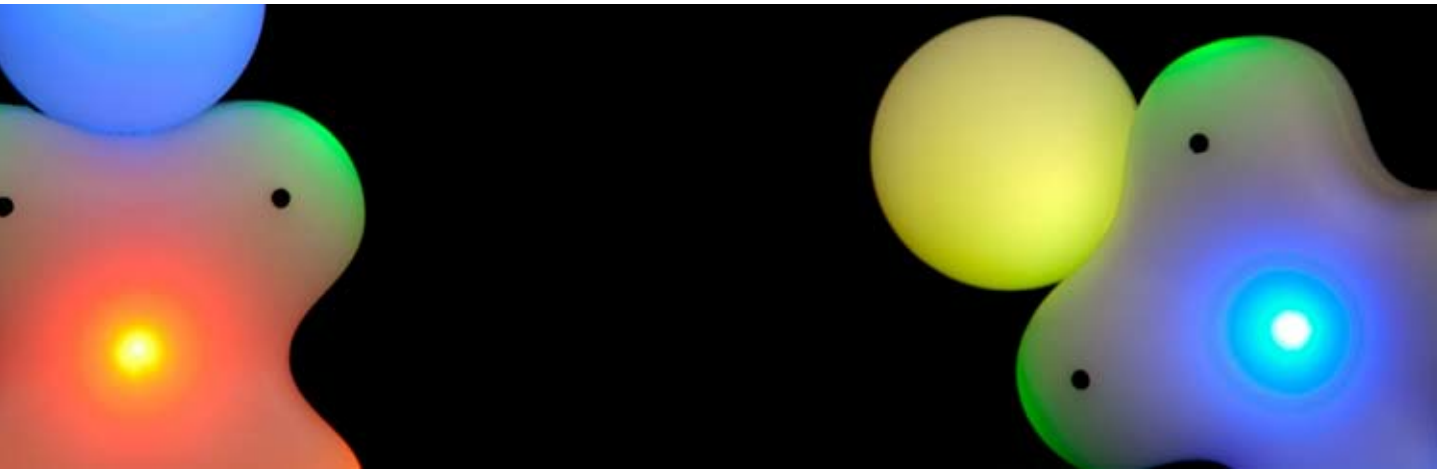
Remote play with loved ones



HEALTHCARE

Scottie supports feelings of connectedness over distance by playing together.

Pilot:
Healthcare

Partners
Waag Society
TNO
Utrecht School of the Arts (HKU)
Nederland Breedbandland (NBL)

Budget
703.000 euro

Key Publications
Astrid Lubsen (2009), Prototyping as a Method in the Design of Playful Objects, Design Principles & Practices.

Astrid Lubsen (2009), Exploring Playful and Affective Remote Communication Objects for Hospitalized Children, CHI workshop 'Tangibles for children'.

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Scottie is a means of play for children who are hospitalized, hence separated from their family and friends. Computers and phones are limited to the use of verbal or text based expressions. Affective communication and feeling connected over distance is established by playing together.

"Affection isn't always expressed in words"

Scottie is the Innovative Pilot Healthcare by Waag Society. Scottie's aim is to explore possibilities of creating virtual intimacy through play with physical objects. Target users are hospitalized children, ten to fifteen years old, and their family and friends. The first challenge was to develop a playful gaming and communication tool. The second challenge is to research whether Scottie actually increases feelings of connectedness between hospitalized children and their loved ones. Currently, user research is being performed by letting ill children and their parents play with Scotties for several weeks.

Representation of dear ones

Scotties are playful, networked objects that enable children to maintain their roles as classmate, brother and son, next to their new role of 'being in a hospital'. Scottie facilitates remote play and communication in an implicit and affective way. The design team created several interactive prototypes: functional demonstrators, paper prototypes or interactive 'black boxes' that illustrate an idea rather than a design. The prototypes have been evaluated with children, in order to better understand the role of sound, color, tactility, gestures, and play elements in the design. Prototyping throughout the design process not only served to evaluate ideas with users, it also helped the designers to develop new interactions.

The final Scottie prototype looks like an abstracted human figure. This figure serves as a representation of dear ones and also has an appeal in itself. Scottie facilitates two forms of play: creating light patterns and creating sound patterns.
Ill children were selected, in cooperation with CliniClowns, to play with Scottie for some weeks. Interviews with these children confirmed the appeal of having an emotional interface to dear ones. Further user research is currently being conducted in cooperation with Delft and Eindhoven Universities of Technology.

Wide-scale use of Scottie

Since the early test results were positive, wide-scale adoption and use of Scottie becomes a serious option. The user research will continue for some months. A customized version of Delft University of Technology's Experience Sampling methodology is developed, which allows the researcher to record feelings and emotions real-time. The gathered quantitative and qualitative data will be analyzed and the results will be disseminated.
In addition, potential exploitation models are being researched, business partners are mobilized, and a plan for producing and distributing Scotties will be written. Waag Society cooperates with TNO to study the development of (social) exploitation models for GATE projects.

Wii games for physical therapy at home

HEALTHCARE

Gameplay as a core ingredient in next gen physiotherapy.

The rise of affordable off the shelf motion controlled game hardware and peripherals, and the success of motion based gameplay as a genre enables the application of games in physical therapeutic settings. Not only in hospitals and care centres, but also at home...

The goal of the Wiihabilitainment pilot is to research and demonstrate the potential of the application of entertaining and affordable motion-based gameplay in rehabilitation. This is done by the development and validation of a prototype for a motion-based game aimed at children that are suffering from Acquired Brain Injury (ABI). The game will address a range of physical therapeutic goals using affordable off the shelf motion controlled game hardware and peripherals. The offered gameplay will be adaptable to specific therapeutic needs and usable in both care centres and home settings. This way the patients can also play with their family and friends.

"Affordable hardware opens doors for game based physical therapy"

Paving the way for game assisted physical therapy at home

Since the costs of healthcare are expected to increase substantially in the next few years, the healthcare sector is looking into the possibilities of transferring parts of the care to the home setting. Game assisted physical therapy is expected to be one of the core ingredients in this transfer. Together with patients, therapists and experts our research team has identified several challenges that have to be met in order for this transfer to become a success: the quality of the game experience should resemble that of a popular commercial motion controlled videogame and the hardware and peripherals should be affordable and easy to use. Also, the gameplay should be adaptable to a range of therapeutic goals and respect asymmetry in background, gaming literacy and physical abilities of both patients and their friends and family. The game will have to provide possibilities to monitor use and therapeutic progress. Last but not least the gameplay needs to be build upon a thorough understanding of physical movement in relation to gameplay. The final result of this Pilot will be a fully playable and validated game demo that addresses the challenges identified above and enables the dissemination of knowledge developed in regard to game assisted physical therapy at home.

Next gen physiotherapy

If we are to develop game assisted physiotherapy to the next stage, we not only need to demonstrate we can successfully design and apply gameplay in the context of home based physiotherapy, but also prove to both the market and the healthcare sector that Wiihabilitainment is commercially viable. Over the next few years we will develop a fully playable demo with the help of patients, therapists and experts. We will also validate the prototypes and game in its context of use, and showcase the potential of games for next gen physiotherapy. The gained knowledge will be aggregated and disseminated to the healthcare sector and the creative industries in the form of demo's, papers, presentations, workshops and symposia. Finally, we will conduct market research and develop a business case in close contact with the sector and publishers.

Pilot:
Healthcare

Partners
Utrecht School of the Arts (HKU)
Waag Society

Budget
625.000 euro

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Sound design for serious games

SERIOUS SOUND

Sound design for serious games requires a systematic approach.

Knowledge Transfer Project:
Sound Design in serious games: methods for design and evaluation

Partners
Utrecht University
VSTEP B.V.

Budget
100.000 euro

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Audio is essential in the experience of entertainment games. Sound effects and music influence emotion and behaviour, and immerse users in the environment and events. Sound design for serious games and virtual training applications faces a dilemma: can non-realistic sounds be used to enhance the experience?

"Sound enhances the learning experience in serious games"

In the development of serious games, the design of soundtracks receives little attention: most effort is directed towards creating realistic and flexible scenarios and high quality graphics. Sound design requires specialist knowledge, with which developers of serious games are not familiar. The goal of this project is to develop an accessible toolbox of methods and techniques for design, development and evaluation of soundtracks in serious games. The tools are focused on important user related aspects of the training: engagement of the trainee, realism and learning goals of the training, and the training context.

Focus on user experience and training goals

In the first phase of this project, two case studies are performed with training applications developed by VSTEP for safety personnel in hospitals and detention centers. Different classes of sounds in training environments are distinguished, such as events (for instance explosions), feedback on actions, ambient sounds that create awareness of the location, communication, and sounds to increase stress and arousal. Some sounds are important in every training level, but complex soundtracks may interfere with the learning process in introductory training. They may also confuse the communication with the instructor, which is an important element in this type of training. For assessing the trainees' knowledge in unexpected and new circumstances, sounds are used to create confusing and complex incidents. For training under stressful circumstances, screams of victims can be added, or non realistic sounds, such as a heart beat, breathing sounds, played at high volume. The training must however still be experienced as convincing. The effect of these additions on the emotional response and on learning will be assessed, and methods for design and testing are evaluated.

Tools and techniques for sound design

Known methods and techniques for requirements analysis, design, user testing and evaluation will be adjusted and extended. They will include specific characteristics of this modality, user response relevant for serious gaming, and characteristics of the context of the training. The project will add to the understanding of the effects of sounds in serious gaming and training, especially on the emotional response of the trainee. It will provide companies with a methodology to develop and evaluate soundtracks, which will improve the quality of the soundtracks and the training environment, and will improve the manageability of the development process.

Creating intelligent games with agents

CIGA

Creating (serious) games becomes more and more complex. The use of agent technology to support the modeling and implementation of seemingly natural behaving characters in the game seems a promising way forward.

VSTEP earlier has created several procedure and incident trainings. Virtual humans play a central role in these applications. Technology currently used limits the variability of their behavior and the range of situations they can cope with. Extending behavior and scope can be very time-consuming. There is much need for more autonomous behavior and the creation of generic models for these virtual humans to increase reusability and efficiency. The use of agent technology can contribute to these problems.

The CIGA project aims to develop a framework that supports the use of agent technology in building serious games. In order for this goal to succeed we will not just develop some software tools to connect game engines and agent platforms, but will also explicitly support translating the game ontology to the agent ontology and vice versa. Finally it will be important to develop methodologies for game design that take into account the possibilities of intelligent agent behavior.

"Agent technology can provide a more intelligent game play"

Intelligent and natural interactions between characters

In order for characters to behave intelligent in a game they have to interact with other characters in a natural way. An important aspect is the communication between the characters and the characters and the trainee. Making the communication look natural, while keeping it very flexible is notoriously hard. An ontology based design of the communication seems to give a good handle on this problem.

Going from scripts to scenes boundaries

The relevance of this research project is both theoretical and practical. Theoretically this research helps to understand the crucial contribution of agent technology in complex systems. Practically it will contribute to the design and implementation possibilities of serious games. The tools and framework developed in this project will support the design of serious games with agents, which will create new possibilities for training that are hard to achieve at the moment without human intervention.

Knowledge Transfer Project:
CIGA: Creating Intelligent Games with Agents

Partners
Utrecht University
VSTEP B.V.

Budget
202.000 euro

Key Publications
F. Dignum et.al. Games and Agents: Designing Intelligent Gameplay. International Journal of Computer Games Technology. Vol. 2009, pp. 1-18.

J. van Oijen et.al. Goal-based Communication using BDI Agents as Virtual Humans in Training: An Ontology Driven Dialogue System, Agents for Games and Simulations

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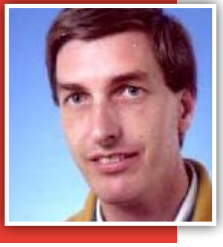

Individual support of employees during organizational changes

AGECIS

Employees need to learn new skills to adapt to organizational changes.

Knowledge Transfer Project:
AGECIS: Adapting Games to Enterprise Culture and Individual Styles

Partners
Utrecht University
Opensa organisatie adviseurs

Budget
200.000 euro

Key Publications
I. Puerta Melguizo, M.C., Dignum, F. & Dignum, V. (in press). Learning for Organizational Change. In ELSIN 2010: European Learning Styles Information Network.

II. Puerta Melguizo, M.C., Dignum, F. & Dignum, V. (in press). Coping with Learning Styles during Organizational Changes. In ECCE 2010: European Conference on Cognitive Ergonomics

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Organizations often undergo changes. Significant changes occur, for example, when an organization decides to become more result oriented instead of process oriented. To succeed, organizational changes need to evolve through phases. A system that guides employees' during these phases, as a function of their learning style, could increase change success.

"Using learning styles to support employees improves organizational changes"

Organizational changes occur in phases from the analysis of the current problems to the creation and implementation of solutions. For organizational changes to succeed, adaptation and employees' collaboration are needed often implying to learn new skills and perform new tasks. Furthermore, people with different learning styles seem to adapt better to these different phases. However, the connection between these phases and learning styles still needs to be properly studied. Our main goal is to develop an adaptive system that fits learning styles and helps employees to learn new behavioral skills and participate properly during organizational changes.

Understanding the relations between learning styles and organizational changes

To explore the relations between learning style and organizational phase, we performed an experiment in which the learning style of participants was measured with the Learning Style Inventory (LSI) of Kolb (2007). Next to it, participants performed tasks that characteristically belong to the different organization change phases. Although a preliminary study, results seem to indicate that different learning styles perform better in different phases and consequently, an adaptive system able to help the different learning styles during the different phases of change appropriately will be a useful tool for organizational change.

Different learning styles perform better in different phases for organizational change

The relevance of this research project is both theoretical and practical. Theoretically this research helps to understand the connection between the organizational lifecycles and learning styles; a relationship established by Kolb's group and frequently accepted in organizations but scarcely researched. Our results support the relations between learning styles and phases for organizational change. We need however to perform more experiments using larger samples as well as with participants that belong to different career populations in order to have a reliable representation of all four learning styles. In practice, the development of an adaptive system for learning skills and procedures, and not only for learning content, will help organizations in the process of adapting successfully to changes. This is an innovative application that will also help to understand the utility of adaptive systems used inside organizations.

Reconstructing the world from panoramic images

CycART

Panorama-based 3D reconstruction of urban environments.

Panoramic images of an environment can give the viewer a great sense of immersion. However, one thing is missing: depth. A 3D reconstruction of the world based on panoramic images opens up many new possibilities and applications.

The goal of this project is to reconstruct urban environments in 3D using panoramic images. A panorama with depth can be viewed on a 3D television, or with simple red-green glasses. In a 3D reconstruction users can easily find the dimensions of a building. It even becomes possible to add virtual objects to the world that interact with the reconstructed environment. However, the real world is a complicated place, and existing image-based reconstruction techniques often fail when used on a real outdoor environment. This project aims to improve current reconstruction techniques, and to demonstrate some of the possible applications.

"Depth adds a new dimension to panoramas"

Lines and planes

Straight lines are common in an urban environment. Building facades usually contain windows, doors and drainpipes, and of course the edges of the building are often straight as well. By finding and matching line segments in multiple images, it is possible to reconstruct these line segments in 3D. Since building façades are often flat, line segments belonging to the same facade will (approximately) lie on the same plane. We use this fact to reconstruct a rough model of the buildings in an environment.

A reconstruction based purely on lines will be incomplete. Therefore, we also attempt to find a depth for pixels that do not lie on any line. Again we can use the observation that many objects in man-made environments can be approximated by plane segments. Specifically, groups of pixels that are close together in the image and have similar color are likely to belong to the same plane. This assumption helps us solve the reconstruction more easily.

We have also demonstrated some of the possible applications of 3D reconstruction in a web-based panorama viewer. The implemented features include occlusion handling of map data, simple point measurement and improved navigation between different panoramas.

Filling holes

The entire world is not made out of planes, and in some cases the assumption that it is will lead to errors in the reconstruction. We intend to detect situations where this happens and so improve the quality of the 3D model. The current models also contain many holes because parts of the environment could not be seen from the images used in the reconstruction. These holes could be filled by combining multiple reconstructions from different images. We will also investigate the use of a building contour map. Even if the contours on the map are inaccurate, the knowledge that a building exists at a certain location will be enough to help improve the reconstruction.

Knowledge Transfer Project:
CycART - Cyclorama-based Automatic 3D Reconstruction Tools

Partners
Utrecht University
CycloMedia Technology B.V.

Budget
200.000 euro

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Automatic annotation of human behavior

VIDART

A toolbox for automatic human pose and gesture recognition.

Knowledge Transfer Project:
VidART – Video Analysis and Recognition Toolbox

Partners
Utrecht University
Noldus Information Technology BV

Budget
300.000 euro

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Human behavior studies are complex and manual annotation of the desired behaviors is tedious. To automate the identification and analysis of human poses and gestures from videos, requirements must be set about the scene. Another prerequisite is a robust method to detect people in the scene.

"Manually human behavior annotation of video is a tedious work"

Noldus Information Technology BV has developed software to manually annotate and analyze human behavior. Automation of human behavior detection can speed up the annotation and analysis process significantly. Using the Restaurant of the Future as a benchmark, requirements are formulated for the system. For any kind of automatic analysis, classification and annotation of the behavior of people from a video, a robust method is needed to detect humans in the scene. For an indoor environment, background subtraction is a well-known detection method, but it faces many challenges such as illumination changes in the scene and shadows casted by moving objects.

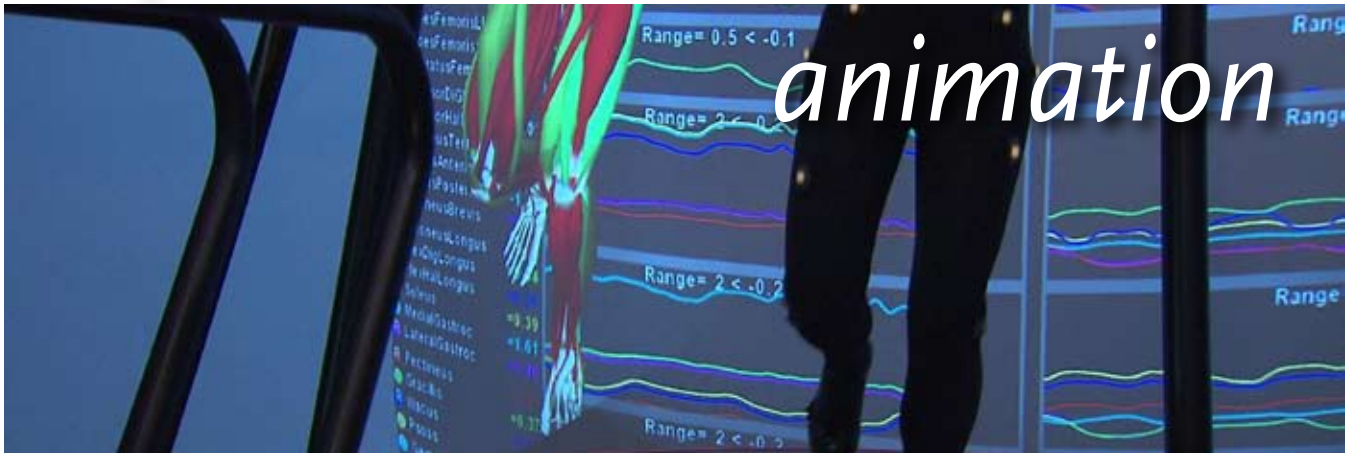
Prerequisites of the system

The Restaurant of the Future is taken as a benchmark to list the requirements on the system (hardware, software, environment and objects). For example, the system must be able to deal with varying illumination, both in intensity and color because of the presence of large windows (influence of sunlight), the large amount of light sources and the different colors of these light sources. Another requirement is that persons have no any additional sensors or markers to ensure a natural recording. To detect people, background subtraction uses a model to represent the background scene. Deviations of the current frame with respect to this background model identify the foreground objects. Several background subtraction algorithms have been analyzed on its performance and accuracy. To handle shadows casted by foreground objects and illumination changes in the scene, a multiple view background subtraction method has been investigated, which uses geometrical information about the scene to detect foreground objects. Often background subtraction gives unreliable or incomplete silhouettes. An alternative method based on level-sets has been investigated to find the contour of the object. The first results show that this method is less sensitive to shadows and illumination changes.

From detection to pose and gesture recognition

Ones the detection of persons is done, the persons have to be tracked and identified over time. The main challenge of tracking is (self)-occlusion, which can be handled by using multiple cameras. When the humans are separated, pose estimation can be performed on each person individually. This will result in the position of each body part, like the head, hands, shoulders, legs and torso. The final part of the analysis toolbox will be the recognition of certain pre-defined gestures. The software has to be tested and verified. The easy way is to use publicly available data sets for tracking and pose estimation. However, to have more freedom in our testing (specifically in gesture recognition), a data set will be recorded in the Restaurant of the Future and a ground truth will be provided.

Physics-based character animation



MOTION CONTROLLER

Developing motion controllers to animate virtual characters using simulated physics.

Knowledge Transfer Project:
Real-time Physics Based Motion Controllers for Animated Characters

Partners
Utrecht University
Motek Medical

Budget
100.000 euro

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Standard character animation techniques directly manipulate the pose of a virtual character. This allows for maximum control, but the resulting motions are often not physically realistic. An alternative technique is to create animations using physical simulation.

The goal of this project is to develop a system that will be able to generate animations by controlling muscle activity or joint torques of a character model in a physical simulation. The resulting motions are expected to be both realistic and biomechanically correct.

Human Body Model

This project is a collaboration between Utrecht University and Motek Medical, a company specialized in using virtual reality and real-time hardware integration for the purpose of rehabilitation. They have recently developed the Human Body Model, a system that can visualize a person's muscle activity in real-time, based on motion capture data.

"The Human Body Model can visualize a person's muscle activity in real-time, based on motion capture data"

The result of this project will be a number of demonstrators and prototypes focused toward integrating motion capture animations and muscle simulation systems for motion analysis and synthesis, based on research performed at Utrecht University.
One of those demonstrators will be an animation evaluation tool that uses the Human Body Model to evaluate the quality of animations that are based on motion capture data. This tool is expected to create a synergy between musculoskeletal modeling and computer animation. Another result will be a tool that is able to generate new motions. This tool will use a musculoskeletal or mechanical model in a forward dynamics simulation, resulting in motions that are physically realistic. Such motions can be optimized for specific criteria, such as walking speed or balance stability.

Applications in rehabilitation

The system is expected to have many applications related to rehabilitation. It can for instance be used as a learning tool that shows a patient how to move optimally with a specific injury or disability. The system can also be used to predict a possible outcome of a specific modification to the musculoskeletal system. This may be helpful in determining the effect of a specific surgical procedure.
This project runs for a total of 2 years and 3 months. The first year of the project mainly consists of research on musculoskeletal modeling and techniques for designing motion controllers. The second year focuses on software development and integration of the software into Motek's applications. The final three months of the project consist of finalizing the development to produce demonstrators, as well as writing publications for scientific conferences and journals.

Spreading the word

DISSEMINATION

Through symposia, conferences and other meetings the results of the GATE project reach a large audience.

Only five years ago game research was by many people not considered to be a serious field. Through the work in GATE and the many dissemination activities people have become aware of the possibilities of games and the exciting game technology for the future.

Over the past three years the GATE project has organized three symposia. The first one, in November 2007, introduced games as a scientific discipline and outlined the work we planned to do in the GATE project. In the second symposium, in February 2009, we focused on the possibilities for serious games in the future, presenting the innovative pilots. And in the third symposium, in July 2010, we gave an overview of the results of the project in the first three years. Each of the symposia attracted over 200 people and led to lively discussion and many further contacts. Two further symposia are planned in the coming two years.

Motion in games

The project supports many scientific meetings. Five times a year, together with the Dutch chapter of the Digital Games Research Association (DIGRA), we organize a meeting with game researchers in the Netherlands dealing with topics ranging from game design principles to animation technology.

We started the yearly international conference Motion in Games (MIG) that was held the first time in 2008. Each year it brings together around 50 internationally renowned researchers in this field who present their ongoing work on topics such as crowd simulation, motion capture, path planning, and facial animation. For more details see the website http://www.motioningames.org.

Researchers of the GATE project give presentations about their work at many conferences all over the world. We organized sessions about the GATE project at a number of international conferences: Intelligent Technologies for Interactive Entertainment (INTETAIN), Computer Animation and Social Agents (CASA), and Affection Computing and Intelligent Interaction (ACII). This made the research in GATE visible to a large international audience.

> *"The GATE project has brought together hundreds of people interested in game development and deployment"*

Also we organize meetings bringing together researchers and developers in game companies to facility knowledge transfer to industry. Most meetings organized by the GATE project are open to everybody. Announcements can be found at http://gate.gameresearch.nl.

Press interest

Over the past years, the Dutch press has become increasingly interested in games technology and its use, in particular for serious games. Participants in the GATE project have been interviewed by all major newspapers like Trouw, NRC, Telegraaf, AD, and De Volkskrant, in technology magazines like Automatiseringsgids, Computable, Control and Intermediair, and in many popular science magazines like Kijk and National Geographic.

Much information about the GATE project can be found at the website http://gate.gameresearch.nl. Here you can read further descriptions of the various projects, you can download factsheets and other documents, and you can find a list of all publications written by participants in the project.

GATE partners

Utrecht University

Utrecht University is the centre of gravity in academic game research and education. It offers master programs on game and media technology and on new media and digital culture. It has strong research groups in various aspects of game technology and game design principles. Current research themes are multimedia and geometry, path planning, crowd simulation, animation, cognition, communication, intelligent systems, new media and digital culture.

TNO

TNO has a strong international position in simulation technology and human factors and applies this knowledge in particular in the areas of Defense and Safety. TNO has a substantial research program on tactical gaming, world modelling, simulation based design, soldier and crowd behaviour, distributed simulation, virtual instructors and virtual teammates, simulator effectiveness and human modelling.

Utrecht School of the Arts

The Utrecht School of the Arts is "the" breeding ground for new generations of game designers. It offers education programs on game design and development, game animation, game art, game audio and interaction design. HKU's R&D program Applied Game Design focusses on the creative aspects of the strategic design and application of games and gameplay to motivate and help players to develop competencies, comprehension or skills that are useful beyond the game itself. The applied game R&D team consists out of 8 researcher/designers and is located at the Faculty of Art, Media & Technology of the Utrecht School of the Arts.

Twente University – Human Media Interaction

The Human Media Interaction Department of Twente University comprises more than forty researchers working on smart surroundings, ambient intelligence, multimodal interaction, speech and natural language processing, multimedia retrieval, embodied agents, virtual reality, adaptive user interfaces and affective computing, games and entertainment computing.

Delft University of Technology

Delft University of Technology participates through the department Mediamatics and its three sections, Computer Graphics, Man-Machine Interaction and Information and Communication Theory. Research on game technology focuses on advanced modelling and visualization, human interaction through gestures, gaze and facial expressions, simulation in crisis management and ambient intelligent behaviour recognition.

Waag Society

Waag Society researches, and develops concepts, pilots, and prototypes at the intersection of new technology and art, aiming for social innovation, focusing on healthcare, art and culture, education, sustainability, and society in general. Waag Society conducts experimental, interdisciplinary research, in close cooperation with a relatively small number of users: 'creative research'. Users have a central position and a large influence on the final project result: 'users as designers'.

Thales

Thales Nederland Land & Joint Systems is the leading defence communications company in the Netherlands. The company supplies both armed forces as commercial organizations with requirements for high technology multimedia networks, with high quality integrated communications systems. It facilitates a Battlespace Transformation Centre that is used to assess new capabilities and to conduct Concept, Development and Experimentation, a process where experts of different areas combine their effort to develop new capabilities.

Game research for training and entertainment

Control.

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