Conference Entertainment

Technology

Improving the quality of life in virtual, augmented and physical reality

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The honorary chairman prof. dr. ir. B. Smolders opening the conference

Introduction

On November 29th 2011, the Electrical Engineering study association Thor organized a conference on 'Entertainment Technology: Improving the quality of life in virtual, augmented and physical reality'. The goal of the conference was to take a look at the progress and, in particular, the application of technology originating from the game and film industry. This day also shed a light on the influence this technology has had on other sectors, ranging from health to art.

The day began with an opening speech from our honorary chairman prof. dr. ir. A.B. Smolders. After this it was time to really start the conference with a lecture about the Remote Handling Study Centre at FOM Rijnhuizen. J. Koning MSc told us that the maintenance is done by a remote controlled robot arm. By using virtual reality, hardware tests and remote human operations, efficiency and robustness can be achieved in a non-human environment.

The second lecture was given by dr. D. Ruijters of Philips Healthcare. His lecture showed us that we are close to 3D images in the surgery room. Using these images, the chances of making a mistake are reduced. But these 3D images still have their disadvantages, like using a sterile head mounted display for the clinician. So the 3D capabilities are exploited to combine 3D and 2D medical information in real-time, in order to provide tools that are tailored to the medical intervention.

After a short break it was dr. C. Chopinaud of MASA Group that took the spotlight and told us everything about MASA Life. MASA Life, the project which she is working on, focuses on Artificial Intelligence and a way to model and design simulated agents that are able to perceive and interact with their environment, including others agents and humans, and can act and think rationally to solve a given set of tasks.

An impression of the conference

During the lunch break a few demonstrations were available for viewing. Firstly, everybody got a change to try the software of the first lecture, of J. Koning about ITER, themselves. Secondly, there was a 3D television in the room which was part of the first lecture after the break of prof. dr. ir. P. de With. The last demonstration was a virtual reality helmet that made you feel like you were on a plane. Last but not least there were two videos of Floris Kaayk which were created with motion capturing techniques.

With a demonstration of the use of a 3D television during the break, it was time to talk about this wonderful piece of technology. Prof. dr. ir. P. de With told us everything about his research to applications of 3D image processing. He showed us how it is possible to view images and videos from another angle than it's recorded with the multi-view algorithm. He also showed us how it is used at sporting matches like tennis or volleyball.

With the illness of dr. ir. B. de Vries, we were very fortunate that two others could take his place. J. Leenen and J. Kraak of GN ReSound told us about their work with machine learning in hearing aids. To make the hearing aid sound better, sound preference elicitation is applied. This technique adapts the sound of the hearing aid to the preferred sound with machine learning. Through repeated tuning in a large search space, machine learning fits the hearing aid for average patient in typical environment.

The last lecture was of prof. dr. B. Otten, who works as a neuromechanics and prothetics professor at the university of Groningen. We may all think that virtual reality these days is pretty good, well think again. Prof. Otten showed us that virtual reality has a long way to go if it wants to be a good tool to simulate reality The final advice is to go to the outside world, it is fantastic there. It has got 2Gpixel camera, the sound matches, it is 3D and you see things that are not in games.

With over a hundred participants we can only say that this day was a great success.

Remote Handling Study Centre Supporting Maintenance of ITER

Lecture: J. Koning MSc. (FOM Rijnhuizen)

About Jarich Koning

Jarich Koning got his MSc in Mechanical Engineering at the University of Twente in 2003. After graduating, he worked as project engineer at Rolan Robotics, VIRO Engineering and Thales. He currently works as a system architect for Heemskerk Innovative Technology BV on the remote handling study center at FOM Rijnhuizen.

About FOM Rijnhuizen

The goal of the Rijnhuizen Dutch institute for plasma physics is to perform research on physics for future energy. FOM is also part of the ITER-NL consortium which aims to have considerable industrial participation in ITER. Other companies in the ITER-NL consortium are TNO, NRG, and the TU/e. It has 150 employees and a budget of 12.8 million euros.

JET Mascot slave manipulator

Nuclear fusion on earth

Nuclear fusion is the process where energy is released by combining, or fusing, multiple atomic particles such as deuterium and tritium. When one wants to do this on earth, confinement is a major problem because of the high temperature needed.

The ITER experimental reactor is currently being built in France to prove fusion is a viable power source. Confinement in this reactor is achieved by using superconducting magnets. According to plan, the reactor will be turned on for the first time in 2018.

Remote maintenance

Because of the high temperature, some components need to be replaced or repaired regularly. However, because of the contamination inside the reactor due to beryllium and tritium deposition, it is not possible to do this by manual handling. Therefore, a remote maintenance system is used where the operator can remotely control robotic slave manipulators to perform the maintenance.

The remote handling study centre at FOM Rijnhuizen

Remote handling study centre

Because the remote maintenance procedures are very complicated and not without risk, it is important to establish a detailed maintenance strategy. These strategies are studied in the remote handling study centre at FOM Rijnhuizen. Activities include: improving compliance with ITER remote handling design requirements; prototyping the remote handling environment, such as the workstation layout and software architecture; and validating maintenance scenarios using simulated reality.

Simulated reality

The goal of this simulated reality is to reduce the need for hardware facilities. Therefore, the simulated reality should accurately simulate the remote reality and all simulated effects should feel natural. They do not have to be perfect though.

For example, visual feedback and interactivity must be available in the simulation. Furthermore, haptics (e.g. force feedback) are also very important. On the other hand, effects like smell and vibrations are hardly relevant.
To achieve visual feedback, no head mounted devices or caves are used, because these devices do not feel natural to the operator. A 'window' through which the operator can look into the simulated world is used instead. To enhance this experience, motion parallax and stereoscopic viewing are currently being investigated.

Part of the simulated remote reality

For interactivity, things like being able to move items around, changing cameras and artificial intelligence in the simulated reality are important. Haptic feedback master arms are used as human-machine interface.

The haptic feedback helps to give the human operator the impression that the manipulator is fixed in the world. Effectively, the human and the machine control the slave manipulator together. This shared control allows for more accurate manipulation. In addition, the haptic feedback helps to simulate physical effects such as inertia, bending and stiffness. On the software side the Nvidia PhysX engine is used to implement the required dynamics.

Validation

To validate that the simulated reality matches with the 'hardware' reality, a hardware test bed at NRG is used. With this test bed common remote handling procedures can be timed both in simulated and 'hardware' reality. Then these timings can be compared to assess the quality of the simulated reality.

The hardware test bed at NRG

Conclusion

Remote handling is part of many activities related to the ITER research product. The remote handling study centre offers relevant experience in line with the ITER standards and methodology. It also provides recommendations for ITER, so that the resulting design is most suitable for remote handling. Moreover, remote handling procedures can be validated in the study centre. As part of this validation, simulated reality is used. To make sure the simulated reality matches with the actual reality, techniques and considerations related with the gaming industry are used.
The remote handling compatibility analysis approach is also generic, and can possibly be expanded into other industries.

Numerous research positions on simulated reality in various fields are available. For example, the investigation of the importance of audio feedback. Please send a message to J.F.Koning@rijnhuizen.nl if you are interested.

Clinical 3D Applications for Minimal-invasive Interventions Enabled by Gaming Industry Hardware

Lecture: dr. D. Ruijters (Philips Healthcare)

About Danny Ruijters

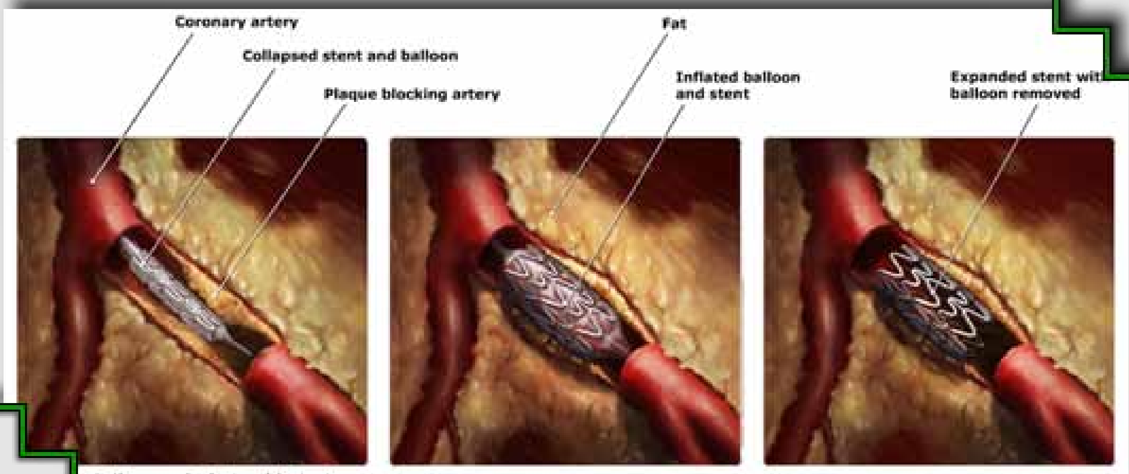
Danny Ruijters received his engineering degree at the University of Aachen and performed his master thesis at ENST in Paris. After graduating for his master degree he joined Philips Healthcare in 2001, and while being employed by Philips he performed a joint PhD thesis at the Katholieke Universiteit Leuven and the University of Technology Eindhoven. His primary research interest areas are medical image processing, 3D visualization, image registration, fast algorithms and hardware acceleration.

PHILIPS

sense and simplicity

About Philips Healthcare

Philips tries to simplify healthcare through combining a unique clinical expertise with human insights to develop innovations that ultimately help to improve the quality of people’s lives. With a growing presence in cardiology, oncology, and women’s health, Philips focuses on the fundamental health problems with which people are confronted, such as congestive heart failure, lung and breast cancers and coronary artery disease. Their focus is to deliver value throughout the complete cycle of care: from disease prevention to screening and diagnosis through to treatment, monitoring and health management. Dr. Ruijters works at the Philips Healthcare campus in Best, which is one of the major sites of Philips Healthcare.



Balloon angioplasty with stent

A stent in a human blood vessel

Artery diseases

Stenotic artery disease is an accumulation of clots that forms a plaque within a blood vessel. It can for example be caused by smoking or very little physical activity. These plaques can stop the blood from supplying oxygen and nutrients to vital organs, which will stop functioning. A form of treatment involves widening the blood vessels with a small metal box, called a stent, placed with a small balloon inflated via a catheter. Although it sounds not too difficult, some vessels are difficult to reach, especially when there are a lot of branches. The blood vessels can be made visible via X-ray if some contrast media is insulated, but these X-rays are harmful for the patient and the clinician. So the amount of radiation should be minimized.

Contribution of the Entertainment Technology

From the images made before performing a surgery very important information can be drawn. But this information has to be provided in real-time, it must be prevented that clinicians will over-compensate, and the initialization should not take long. To achieve this, some fast graphical processing power is needed. The entertainment industry drives the developments of almost all graphical processing hardware, such as GPUs, which can process a lot of data at the same time. It will take a while before the new techniques like virtual reality are accepted in the conservative medical business, because techniques usually have to prove themselves before they can be applied to surgery on people.

A rendering of the vessels in the human head

Combining information

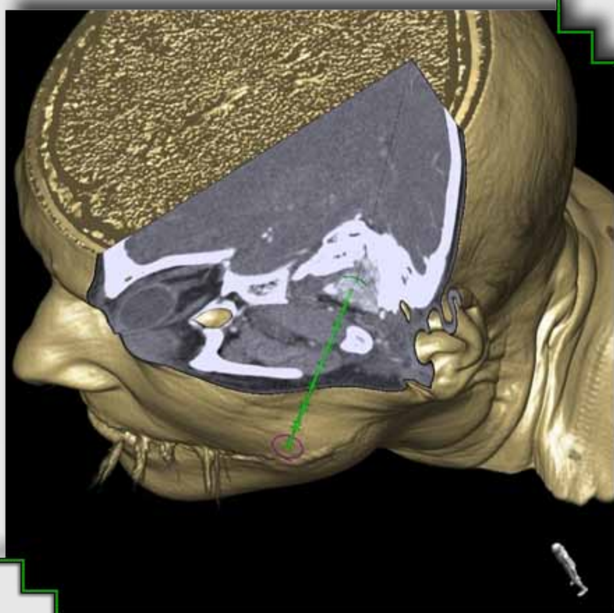
When a patient undergoes surgery prior visualizations can be combined with new information. It might be useful to use the 3D capabilities of an MRI scan during an intervention. For example head mounted displays could be used for extra depth in information, but the clinician has to look at a lot of things during the surgery and head mounted displays are cumbersome during medical interventions (e.g., consider sterility). So the 3D capabilities are exploited to combine 3D and 2D medical information in real-time, in order to provide tools that are tailored to the medical intervention. Some of the algorithms that have been explored concerned fitting 3D images on a real time X-ray image. It proved that GPU can be fifty times faster than a single core CPU. With the fitted prior information the clinician can see which vessels have to be followed, which can be used to lower contrast media usage.

Head Tumor

Some tumors are treated by injecting glue into the tumor vessels, to block blood supply to the tumor. Oxygen and nutrients cannot reach the tumor and the cells will die. But with brain cancer the tumor is often very difficult to reach. With a needle the appropriate blood vessels might not be reached at all. By combining old and new information the precision grows so the chance of failure drops.

Image guided interventions

The amount of image guided interventions and therapy is rapidly increasing. It is important that clinicians can rely on the accuracy and reliability of new techniques more than the Entertainment Industry does now. Nowadays most bugs are not in the algorithms, but in the code which is used. So, more research is very important.



Needle Planning

MASA Life: A Solution for the Design and Development of Intelligent Agents

Lecture: dr. C. Chopinaud (MASA Group)

About Caroline Chopinaud

Dr. Caroline Chopinaud got her doctorate in Artificial Intelligence in 2007 from UPMC (Université Pierre et Marie Curie), the leading French Scientific and Medical University located in Paris. She currently works at MASA Group as a research and development engineer.

MASA Group

MASA Group is an international editor in advanced software in the simulation and serious game industry. They mainly work on software in the context for the Defense and civilian security. MASA Group consists of 60 people and has locations in France, Germany and the United States to address the north American market. They recently branched out to Germany in 2011 for AI Technologies. MASA Group develops and sells essentially two products: MASA Life and MASA Sword.

MASA Life

Based on over 15 years of focused research and development activities, LIFE brings unparalleled Artificial Intelligence capabilities to the world's simulations, training applications, and serious games.

Designed for developers requiring highly realistic and adaptable intelligent behaviors, LIFE is a powerful AI-middleware that marries an intuitive development environment with an unmatched level of control and flexibility. LIFE brings a powerful dimension of human realism to simulations, providing users with the most reliable and actionable data for training and analysis.

In November 2011, MASA acquired key intellectual property rights and hired an AI product development talent from Artificial Technology GmbH, a German developer of Artificial Intelligence middleware for the games industry. This acquisition will enable MASA to leverage advanced AI features developed for the games industry – such as navigation (path-finding and steering systems), perception, planning, decision and analysis – into its current product roadmap. At the same time it allows MASA to accelerate the near-term evolution of LIFE towards a truly cross-industry solution that addresses MASA's existing customer base as well as the needs of the game development market. Through an accelerated, iterative development approach, users of LIFE will be able to easily and reliably create advanced, customized AI capabilities for their simulations, virtual environments and serious-games applications.

MASA also plans to leverage Artificial Technology's innovative cloud-ready AI middleware technology, which is currently used in massively multiplayer online games (MMOGs). MASA sees a strong potential for this technology to power a new generation of highly portable, and broadly accessible simulation platforms that will help solve the challenges of massive, distributed 'large command post' exercises in various sectors. By taking AI off the desktop and into the cloud, MASA and its LIFE product will create new opportunities for simulation developers as well as more immersive and realistic training and planning scenarios for end users.

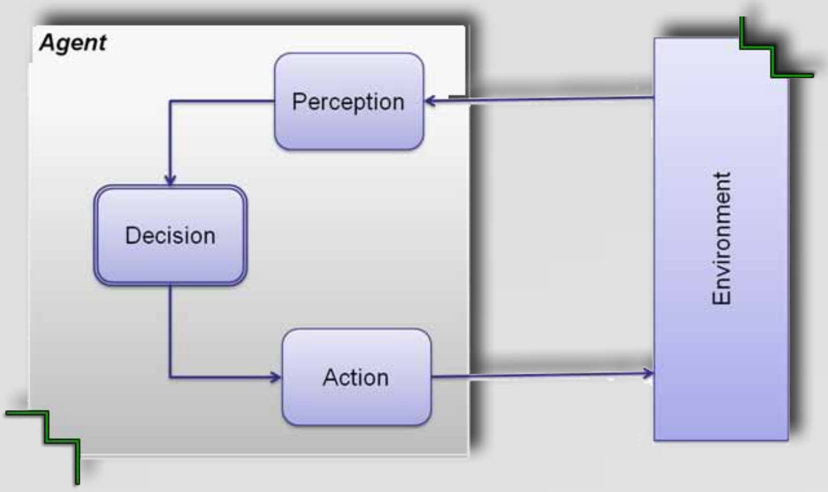
Origin

One of the problems in simulations is that simulated entities are commonly manipulated by human operators. During a training, the trainers must move the simulated characters and execute interactions with the interface to immerge the trainee in a realistic situation. This manipulation is viewed as fastidious and is prone to error, which makes it an interesting area of improvement to explore. The main goal of MASA Group is to propose a solution to reduce the intervention of human operators and to automate the behaviors of the simulated entities by using intelligent agents.

Intelligent Agent

Next, the audience was introduced to the concept of an intelligent agent. An agent is a "computer system situated in some environment that is capable of autonomous action in this environment in order to meet its design objectives" [Woolridge&Jennings1995]. An intelligent agent needs to be able to perceive and act through its environment by using its own resources. To create a realistic agent, there are three parts to the process: the rational agent, autonomous agent and adaptive agent. A rational agent chooses the best possible action in a given situation. An autonomous agent provides simulated entities with the capabilities to take its decision on its own to resolve a given goal.

An adaptive agent increases the robustness of the behaviors by being able to dynamically adapt their behaviors to the environment dynamicity. The action loop of an intelligent agent is to perceive the environment, make a decision and take action. The decision part is the main point in this architecture, where we have to know how the agent is able to deduce the actions to execute from the perception process. This part is also named the “actions selection problem”.



Perception Decision Action Loop

SWORD is MASA’s flagship COTS software. It is a powerful aggregated simulation tool automated by MASA’s cutting-edge Artificial Intelligence technology. Designed to help users in the military, civil security and research communities develop and deploy complex, highly-realistic training scenarios and analysis, SWORD offers an open and interoperable platform for integration with existing C2 and simulation systems. SWORD has been implemented by some of the world’s largest organizations and militaries to help them be better prepared for a world of ever-changing possibilities and outcomes.

The latest version of SWORD also features a new service-oriented architecture (SOA), designed to make cutting-edge cloud-based simulations a reality today.

SWORD enables efficient training & analysis corresponding to either Defense or Security needs:

For Defense applications : a complete solution for multi-level training of corps, brigade or battalion commanders.

For Security applications: a complete solution designed for crisis management training staffs, emergency managers and community leaders.

Dr. Chopinaud during her lecture

An impression of a simulation for efficient training and analysis by MASA sword.

Conclusion

MASA Life is a complete framework which proposes a high level design using modeling language and a behavior implementation language. There is a powerful decision engine based on the free-flow hierarchy principles. MASA Life provides a solution to design, implement and debug the brain behaviors and provides a knowledge base and interactive skills. But the solution is limited by being dependant on the capabilities of developers to implement the decision tree. That means a huge conflict for MASA Group when it comes to appeasing their main target group of non-developers trainees or trainers.

To improve their products, MASA Group's future goal is to propose a new method that is more accessible. They also propose a high level design solution without the development stage, no modeling language and no implementation behavior language, only a fully graphical editor to define the behaviors and the knowledge of the world. Lastly, due to the complexity of the free-flow hierarchy, MASA Group searches for a simpler version of this architecture that will achieve the same goals.

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Mobile training set-up of FOM Rijnhuizen

A mobile training set-up has been demonstrated during the lunch break. This set-up consisted of a haptic feedback input device and a computer system running the simulated reality software as used in the remote handling study centre. With this system, participants of the conference could practice positioning and fastening a bolt with a remote controlled manipulator.

One of the participants at the FOM demonstration

3D Television of prof. dr. ir. P. de With

Participants at the 3D television

During the break of the symposium, there was a demonstration of the VCA group. In this demonstration you could see a scene on the television with semantic parts. One of the examples was a video of a ballet dancer, in which you could pan the camera around the dancer. The scene was rendered in 3D by using a powerful graphics card. This demonstration showed the possibilities of object oriented video processing.

The game Snow World of Cybermind

Cybermind brought a clip of the game "snow world", which was meant to help people with scalds. When the bandages of people with these burn marks are changed, they are in a lot of pain. To lessen the pain a head mounted display is used with this "snow world" game. This game shows snow and ice, with the objective of throwing snowballs at snowman's, which takes the attention away from the pain.

Vurtual Simulations of CleVR

CleVR creates virtual simulations for different purposes. By using head mounted displays their simulations can be realistically experienced. Their demonstration at the symposium was a simulator of a travel by flight. This simulation was meant to study reactions of people with Pteromerhanophobia, the fear of flying. Psychologists can use the information of this experiment to help or maybe even cure this phobia.

Participants talking to a employee of CleVR

Movies of F. Kaayk

Metalosis Maligna

Metalosis Maligna is a documentary about a disease that affects patients with medical implants. This condition occurs when a metal implant interacts badly with human body tissue, causing the metal to grow tendrils. These eventually puncture the skin from within and destroy it.

The movie shows the development of the disease from its early stages through to the shocking advanced stages, with a spectacular ending where entire sections of flesh have fallen away and all that is left is a skeleton of scrap metal.

Metalosis Maligna

The order electrus

Nature adapts, even to human actions that seem to destroy everything. The amazing power of evolution has given birth to a new species of insects. Their ideal habitats are old industrial locations. Some call them electrical insects, others simply speak of a miraculous phenomenon, or even better, a self supporting order; the Order Electrus.

The order electrus

For more information, see:

http://www.floriskaayk.com/work.html

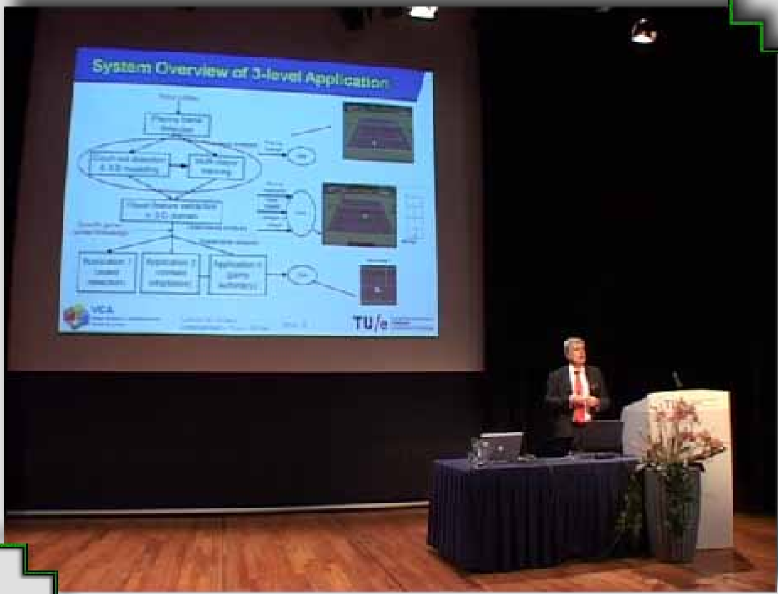
Prof. dr. ir. de With during his lecture

About Peter de With

Peter de With got his Master of Science in Electrical Engineering at the University of Technology in Eindhoven and his Ph.D. from the University of Technology in Delft in 1992. He joined Philips Research Labs Eindhoven in 1984 and worked in different TV departments and coding. He currently works as a professor at the University of Technology in Eindhoven, is director of C3Te, the Center for Care and Cure Technologies Eindhoven and works with the VCA (Video Coding and Architectures) group of the Signal Processing Systems department from Electrical Engineering.

Video Content Analysis and Applications

Many applications need the analysis of the contents of a video. One example of an ongoing project is the identification of a ship and its contents in the harbor of Rotterdam. The analysis of the video results in the identification of ships and their respective names will be then displayed on the video output. Another project is the analysis of the behavior of epileptic patients to predict seizures. Other projects using this technology are also being done, but the current focus of the VCA group lies in 3D technologies.



Prof. dr. ir. de With during his lecture

3D in the future of multi-media

Today video-processing and multi-media are 2D centered, so there is no high-level information extraction of this 2D signals. The future in multi-media will be object-oriented and there will be new possibilities by using 3D models in 3D videos. By making the data object oriented, static backgrounds only need to be transferred once, while the moving objects are refreshed at a higher rate.

Another interesting reason to make the video object oriented is multiple semantic parts in the videos, which gives the audience the freedom to look at different objects from different angles and zoom levels.

Realization of object-oriented video processing

It is not simple to implement a system this complex. When the system receives the video input it should immediately detect the 3D models and apply multi-player tracking. The multi-player tracking tracks multiple moving 3D models in a scene, like a tennis match in which you want to follow both players.

Then the system can extract further information from the video to use in other applications, like event detection and content adaption. To map the real world properly, special algorithms have to be used to describe the scene in real world coordinates. Using these coordinates it is possible to apply a semantic analysis. A background model is used along with change detection and modeling to have a multiple-object environment.

Multi-view video

For multi-view videos the system should receive a 3D video with multiple input views to be encoded, transmitted and decoded. The decoded video is then interpolated and adapted to the wishes of the audience and sent to the 3D display. The multiple inputs are blended to create one 3D multiple-view environment to be displayed as a virtual view. Only a high-end GPU will be able to render these complex 3D videos.

3D Reconstruction

A high-tech robot equipped with five HD cameras and a laser to detect distances between objects can be used for 3D reconstruction. The data acquired is used to make a 3D reconstruction of the environment the robot has scanned. With a full representation of a scanned environment it is possible for end-users to have a detailed virtual 3D map of a building with its internals en externals.

Conclusions

The emerging 3D technology in video is certainly very promising. Being able to have multi-views of multiple 3D objects is very useful for both the entertainment and business sectors. Reconstruction of environments such as buildings in a full 3D virtual view allows end-users to view various locations in a detailed way without actually having to go there. This implies that this technology will probably be very common in the near future.

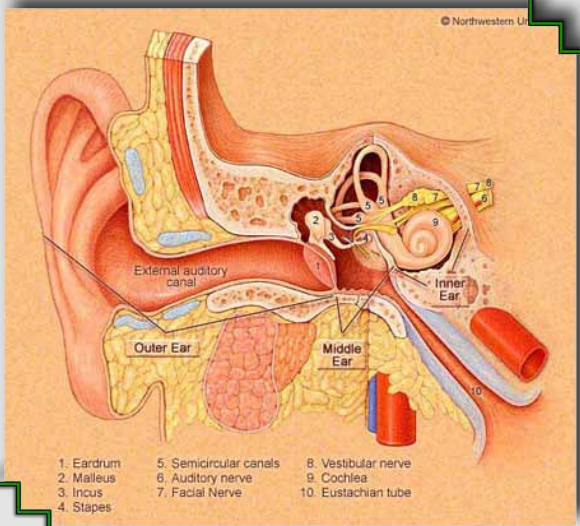
About Jos Leenen

After graduating for his bachelor Audiology at Fontys Hogescholen, Jos Leenen studied Electronics and Physics at Eindhoven University of Technology. From 1985 till 2000 he worked for Philips at the medical devices industry. He is currently the director of algorithm development at GN Resound.

About GN Resound

GN Resound started in 1943 as 'Danavox' . In 1989 the company had a major breakthrough with Wide Dynamic Range Compression, a new technique for hearing aids. In 1992 it was the first company to introduce a hearing system with digital signal processing. The last twenty years, GN Resound has mainly focused on improving the quality, size and comfort of their hearing aids. One of the latest breakthroughs is a wireless technique which makes it possible to adapt the hearing aid without plugging it in.

ReSound
rediscover hearing



The human ear

The Human Ear

In the human ear sound waves are converted to electric pulses to be sent to the brain as follows: vibrating air pushes towards the ear drum, the ear drum moves a few tiny bones in the inner ear, these bones push in turn against the cochlea. The fluid inside the cochlea starts to move and cells with tiny hairs (cilia) sensitive to pressure react to this movements and generate electric pulses which go directly to the brain.

Hearing loss can be caused by a mechanical problem with the bones or ear drum (conductive hearing loss) or by damage inside the inner ear or brain (sensorineural hearing loss). Only conductive hearing loss is reversible.

Hearing Aid Industry

A shocking one in five Americans show signs of hearing loss of 25 dB or above according to Johns Hopkins university. In the Netherlands, an estimated 10 percent of the people suffers from hearing loss of 30 dB or higher. Therefore, the hearing aid industry grows with 4% per year and grosses about 5 billion euro each year. Despite of the hearing loss, 1 in 5 people with a hearing device leave it inside the drawer and do not use it because they think it is unnecessary or because they are ashamed of it.

Digital Signal Processing

Digital Signal Processing inside hearing devices make an estimation of the original signal with the Fast Fourier Transform and amplify it. DSP systems have some real advantages: they benefit audibility, intelligibility and derecruitment (a sudden rapid growth of loudness inside an ear). However, a hearing system with DSP may also cause signal distortion, all kinds of noises , loss of bandwidth and, last but not least, a lot of money and time. Therefore, new and better solutions for hearing systems have to be found.

Jos Leenen during his presentation

One of the possible solutions is frequency-warped signal processing. The unit delays of a digital filter are replaced with first-order allpass filters (a filter with a constant magnitude response) to obtain a variable digital filter. This filter can be controlled by adjusting the coefficient of the allpass element. This way, a non-uniform spectral representation of the signal can be computed. The benefits of this method are its low computational load, natural time-frequency analysis, low latency and no aliasing. Surround sound can be achieved by band splitting the audio signal and filtering it with a high pass filter. The direction where the sound came from is then calculated and the signal is mixed again. Via this technique it seems like the sound comes from a certain direction, making it more realistic.

Machine Learning for Personalization

To make a hearing aid sound better, sound preference elicitation is applied. This technique adapts the sound of the hearing aid to the preference of the user with machine learning. Through repeated tuning in a large search space of frequencies, machine learning fits the hearing aid for average patient in a typical environment. The test user listens to multiple? hearing aids, and must indicate which one he prefers. The machine learning algorithm then calculates a prediction model and the design of the hearing aid is adapted. The test user then listens to adapted hearing aids again. With a few iterations, the final model is calculated.
Main future goals are to make the tuning cost only 15 minutes and to make it fully automated.

Long Term Vision

In the future, the manual tuning of the hearing aids by the audiologist will be replaced by automatic tuning through the web or mobile phone, using machine learning, optimization, modeling, and user feedback.

Game Technology and Human Neuromechanics

Lecture: prof. dr. B. Otten (University of Groningen)

About Bert Otten

Professor Bert Otten works at the University of Groningen at the Center for Human Movement Sciences which is specialized in neuromechanics. He is a software developer of NBody, a human body model toolbox and virtual camera, inventor of several mechanisms as extensions to the human body and founder of AlgoPhot, a firm for photography and algorithms. His specializations include healthcare, scientific research, interdisciplinary informatics and neuroscience.

Introduction

A video about a young girl is shown as an introduction to the lecture. She looks surprised, smiles and is clearly attracted to the picture she is looking at. But the picture itself, a heart of flattened grass, does not look realistic at all. So apparently realism is not necessary for attraction, an interesting observation.

Another weird observation is the following: when someone is cutting tomatoes, he does not know why and how his muscles work. Somehow that knowledge is not necessary to make the process work. These situations are very interesting examples of how complex the human brain is and they also apply to gaming. The fundamental questions to be answered are why games work, how they work and which limitations there are.

Game technology

It all started in 1958 when William Higinbotham used an oscilloscope to create the first multiplayer game 'Tennis for Two'. A lot has changed since then and nowadays gaming involves fast processors and complex calculations. One example is a boat game developed by professor Otten himself. The gamers have to steer a boat through a level by tilting the platform they stand on. The players have to combine what they see and what they feel into one process which is very difficult to accomplish. What is the nature of these processes and how do they work together to make gaming possible?

Prof. dr. Otten during his lecture

The visual system

Humans always tend to keep their eyes fixed at one point. During a walk the eyes make a countermovement every step taken, so the gaze remains stable. These mechanisms work within a millisecond. Way too fast for a human being to realize that, because meanings and feelings are coupled to an image after the normal image processing. They are simply too slow.

The brain does not process a certain concept in a certain area, but the concepts are spread all over the brain, apparently at random, making it very complex to understand.

A brilliant example of image processing by the human mind is the school of Athens painted by the famous Raphael Santi. It is visible that the 3D world is flattened at the painting because the spheres the philosophers are holding at the right bottom of the image are round and not oval.

But somehow a flattened image looks more realistic than one placed in the right perspective. This is probably the case because the brain uses 'Photoshop' all the time; It uses the overlap between the pictures from both eyes to create one image. This results in a flattened image, so flat pictures look more realistic to our mind.

The brain uses some other amazing tricks as well. It makes curvy lines straight and it even fills in details by itself, like when it fills in missing parts of a bus behind a tree. This amazing trick is called spatio-temporal relatability. This is great for gaming when the graphics are bad, but disastrous when crime scene witnesses have to be interviewed.

As can be seen in 'The school of Athens' by Raphael Santi, a flattened 3D world looks more realistic than one placed in proper perspective.

Theory: virtual reality in gaming is really poor

Realism is not needed for attraction like stated in the introduction. The realism is therefore quite poor in video games. The precision of the human eye is about 0,017 degrees. Distributed over a half dome times two eyes, about 1 gigapixel can be seen at a time. The best computer screen at the moment has a resolution of about 2 megapixel, which means that the quality of the computer screen is 500 times poorer.

It gets even worse when it comes to moving images. During the tracking process, an eye can see about 180 images per second. Combined with the high resolution, this amounts to 20 000 frames per second. Compared to the current computer screens of 100 Hz, this gives a quality ratio of 200, so the total ratio between optics and VR optics is 100 000.
Embodied cognition

Embodied cognition states that the way the brain works depends on the body it lives in. When someone writes on a piece of sandpaper with a pen, he feels roughness in the tip of the pen, even if he has no neurons there. There must be a connection between sensing and movement.

If somebody else holds his hand while writing on sandpaper, he also feels vibrations, but not in the tip of the pen. Movement and sensing are now separated. A weird observation, so there probably are no vast brain areas assigned to these tasks. Everything is reclassified in every new situation. The process takes care of itself.

The premotor Cortex

The premotor cortex, a part of the brain, is used during movements, memorizes how they work and plans how to make these movements next time. If somebody practices something and is being told how to do it at the same time, he fails. The premotor cortex attains new information on the moves it has planned and tries to adapt them. The best way to learn new movements is to do something first and to plan it afterwards. Compare it to people who need to learn how to walk again. When someone says: 'Think about your foot!', they have no balance anymore.

The near-hand effect

A computer mouse is a hell for the brain. The brain has to make a difficult translation from a horizontal plan to a moving target. To improve gaming, one could make a transparent screen so the hand is visible inside the gaming world. The brain reacts differently that way.

Compare it to a situation where one lifts a weight with one of his hands. The hand does not move when he picks up the weight himself with his other hand. However, if somebody else lifts the object the hand tends to go up.

During a similar test, the weight is connected with a rope. When one lifts the weight with the rope, the other hand does not go up because the brain still recognizes the result of the action. But when one pulls the rope via a pulley, placing the other hand out of sight, the lifting hand does go up. The brain only understands the result of the action when both hands are together and visible.

The problem of immersion is often solved by placing avatar on the screen. This makes the translation of the figure easier and improves the embedding of the gamer inside the game.

Eye-hand coordination

An effect which is related to the previous one is the eye-hand effect: If one sees his hands close by, he will see things better. A possible explanation for this effect is that the brain possesses neurons that work in visual as well as in technical areas. What one sees, feels and grabs is connected someway. This is the reason why touch screens are more effective. So a computer mouse is really inefficient, because there is no near hand effect and one has to make difficult translations when he uses it.

After a visit to a climbing hall, the brain reacts fearfull to similar colored patterns on walls because of the association with dangerous heights.

Recalibration

The brain constantly adapts to the environment. If people play a balancing game and the directions slowly change, they do not even notice. If one stands on a moving platform while watching a rollercoaster movie, he has more trouble keeping his position than without the movie, because he expects things that are not there, like gravitational forces.

Time lag and dynamic fidelity

Despite all the difficulties, gamers get used to time lags in games. They learn to move differently to get their goals anyway. The time lag needs to be way below 0.1 second to use hand-eye coordination feedback. With a time lag of 110 ms gamers move 1.5 times slower and with a lag of 220 ms even two times slower.

The dynamic fidelity is also pretty bad in most games. One picks up a rock in a Wii or Kinect game like it is a peanut. It is not realistic at all.

Emotion versus control

Inside a climbing hall people with a fear of heights show signs of sway (movements of the body from left to right) and sweat a lot.This could mean that the sway is caused by the fear of falling down. To prove this statement, the climbing hall has been rebuilt in virtual reality and the same people are being put to the test. The people knew they could not fall down, but showed the same signs of sway. So swaying must be a motion paradox. This effect can be taken away by allowing people to hold a ball on a stick, thereby giving them an anchor to look at. A black and white virtual reality world proved to be not as scary as a colored one, because some parts of the brain react fearful to the colored pattern on the walls of a climbing hall. So once again, emotion and logic are separated inside the brain.

Conclusions

Game technology works thanks to our imagination and adaptability. The games offer a poor version of the reality and the brain fills in the details itself. Also, game technology does not transfer to experiences in the real world, unless there is sufficient dynamic and sensory fidelity. Time lags, unrealistic physical abilities inside games and translations from keystrokes to movements inside the game world confuse the brain. Game technologies cannot be used to simulate the real world until these are improved.

So, games are fun for rehabilitating and interesting for scientific research, but for the rest the real world is more suitable.

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